Vol. XV. — No. 9. September 1933.

BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

(ENGLISH EDITION)

[385. (06. 112]

TWELFTH SESSION

Cairo, 19-30 January 1933.

GENERAL PROCEEDINGS

First Section : **WAY AND WORKS.**

INAUGURAL MEETING

20 January 1933.

PROVISIONAL CHAIRMAN : Mr. J. R. PAUL,
MEMBER OF THE PERMANENT COMMISSION OF THE ASSOCIATION.

— The Meeting opens at 9 a. m.

The Chairman. — Gentlemen, I have been requested by the Permanent Commission to preside over the opening Meeting of the 1st Section and to make up its Secretariat.

On behalf of the Permanent Commission, I suggest that Mr. D. VICKERS, director, London Midland & Scottish Railway, be elected as President. His talent and enlightened competence will doubtless enable him to successfully direct the discussions. *(Applause.)*

I furthermore propose as principal secretary Mr. G. L. A. DUCHATEAU, Engineer, Belgian National Railway Company. *(Applause.)*

— Messrs. VICKERS and DUCHATEAU take their seats.

The President. — I feel very much the honour which has been conferred on me by my appointment as chairman of the meetings of this important Section. I will endeavour to be worthy of the confidence you have placed in me and do my best to

assist the solution of the questions we have to deal with.

We now have to proceed to the appointment of the vice-presidents.

I suggest that the following Gentlemen be elected :

Messrs. O. Aubert, chief engineer, Norwegian State Railways;

H. Flensborg, chief engineer, Danish State Railways;

Dr. Y. Tanaka, engineer, Department of Railways, Japan.

(Marks of approval and applause.)

— On the proposal of the President, the Section then completed its Bureau and drew up a provisional agenda.

[625.162 & 656.254]

QUESTION I:

The protection of level crossings in view of modern developments in road traffic.

Preliminary documents.

1st report (America, Great Britain, Dominions and Colonies, China, Japan and Egypt), by Mr. M. A. NEWLANDS. (See *Bulletin*, April 1932, p. 329, or special issue No. 2.)

2nd report (Belgium, Spain, France, Italy, Netherlands, Portugal and their Colonies, Denmark, Finland, Luxemburg, Norway, Sweden and Switzerland), by Mr. BATICLE. (See *Bulletin*, August 1932), p. 1641, or special issue No. 25.)

3rd report (other countries), by Mr. A. MISZKE. (See *Bulletin*, July 1932, p. 1283, or special issue No. 20.)

Special Reporter : Mr. A. MISZKE. (See *Bulletin*, January, p. 1.)

DISCUSSION BY THE SECTION.

Meeting held on the 20 January 1933.

PRESIDENT : Mr. D. VICKERS.

— The Meeting opens at 9.30.

The President. — I shall first of all call on the Special Reporter, Mr. MISZKE, who will briefly expound the question. I shall then ask Mr. Newlands and Mr. Baticle if they have anything to add. If no discussions are necessary we will then pass to the sections of the report which is in the hands of everybody and take them one by one and the discussions will follow in due course.

Mr. Miszke, *Special Reporter* (in French). — The first part of our report shows that the legal requirements and regulations governing level crossings differ considerably in the different countries.

Road traffic, which formerly was entirely local, has been transformed into a mechanised traffic at high speed and over long distances, and it is becoming to a large extent international.

It would be a great avantage if the legal requirements and the regulations,

and also the methods of protecting level crossings resulting therefrom, as well as the obligations of the road users, were the same everywhere.

There does not appear to be any good reason why the form of the signals, the level crossing gates, the methods of lighting the latter, the conditions of visibility, the obligation of slowing down or of stopping before level crossings, should not be made uniform everywhere.

As regards the road traffic, we are of the opinion that the vehicles should be required to stop before unprotected level crossings not fitted with automatic signals if the visibility is not sufficiently good.

In the case of unprotected level crossings, which are very visible or fitted with automatic signals, the speed of the road traffic should be limited to 25 km. (15.5 miles) an hour.

The setting up of the *warning signal on the road* is rapidly becoming general on most of the railway systems. In Europe, in conformity with the International Convention of 1926, the triangular type of signal is the one most used. In other parts of the world, warning signals of other and very differing types are used. The United States of America have a special type which is used on a large scale.

In Germany, the opinion is that from the distance of 200 m. (656 feet) the example of Switzerland should be imitated, in which country every 50 m. (164 feet) between the warning signal and the level crossing, distance indicating posts are erected.

It would also be desirable to locate this signal in a uinform manner according to the local conditions of each level crossing.

As regards the division of the costs of protecting the level crossings, or of abolishing them, the replies from the countries consulted enable us to report that it is being more generally appreciated that the necessity for this work is due to the development of the automobile traffic and the opinion put forward only a short time ago that these costs should fall solely upon the railway companies can no longer be maintained.

As a matter of principle, the railway should not take any part of the cost of making and maintaining the crossing, if the protection and signalling are due to the construction of the improvement of the road.

In the case of the construction of an over or under-bridge, almost exclusively for the benefit of the road traffic, the railway should at most share in these costs to the extent of the sum representing the cost of protecting and maintaining the level crossing converted into capital.

As a result of the influence of the road traffic an endeavour is being made to improve the visibility of the level crossing gates.

As the present method of painting the gates and the fact that they are fitted with red lamps at night do not prevent the number of accidents through collision with the gates from being considerable, and as these measures do not meet the object for which they are installed, in most cases, it may be concluded that these troublesome and costly methods ought to be given up — the lamps especially — and that the gates should merely be painted in coloured stripes, be fitted with reflectors and, in the case of very heavy traffic, the level crossing be well illuminated.

The automatic signalling of approaching trains is widely installed in the United States; it is in use in many cases in Australia, Canada, Italy, Japan, New Zealand, Sweden and Switzerland. Such equipment is being used experimentally

in Germany, South America, Belgium, Brazil, Ceylon, Finland, France, Norway, Poland and Jugoslavia.

According to Mr. Baticle's report and our own, favourable opinions on the future use of this equipment have been given by Germany, Belgium, Denmark, Spain, Finland, Italy, Norway, Poland and Switzerland.

When high-speed motor traffic is under consideration, we do not consider that level crossing gates are the best method of protection. A gate closed across the road forms a method which ought to protect the road user against a possible accident, but as the statistics of accidents from collisions with the gates show, the gate itself is a source of danger to the road traffic.

By replacing the gates, where the intensity of the road traffic makes it possible, by automatic or fixed signals, according to the degree of visibility, we follow the suggestions made at the London Congress where it was recommended to suppress the crossing keepers; this would lessen the annoyance caused to the road traffic by excessively long stops, and in our opinion would increase the safety.

Today in view of the general financial crisis, the large number of people out of work and the excessive railway staff, it may be that abolishing the level crossing keepers does not appear quite so pressing a question as it was several years ago. But when normal conditions return and in view of the necessity for making the operation of the railways cheaper, if only because of the competition of road motor transport, the tendency to do away with level crossings keepers will certainly increase.

We are of the opinion that the practice today puts in the first place on the same footing as the level crossing gates, if not before it, the automatic light signal.

Seeing that the United States of America have had the greatest experience of it, we would go as far as to suggest the application of the type adopted by the American Railway Engineering Association, completed by a notice requiring the speed to be reduced when approaching level crossings.

Fixed signals in the form of a St. Andrews Cross should be introduced progressively whenever possible, and as motor traffic increases, at all unprotected level crossings not fitted with automatic signals, provided that the speed of the trains is not exceptionally low, as for example 15 km. (9.3 miles).

As good visibility is essential and more important, more efficacious even than crossing keepers, it should be considered desirable to obtain such changes in the legal requirements as to make it possible to assure permanent good visibility.

The efficacy of the signal given by the locomotive whistle is becoming more and more doubtful, owing to the varying train speed, as well as the very wide differences in speed between horse vehicles and automobiles. In addition it is lessened for the drivers of motors by the noise of the motor and the increasing use of interior drive vehicles.

In addition, it is desirable not to distract the attention of the locomotive driver who has to observe, before anything else, the block and station signals.

We think, therefore, that the use of the whistle should be limited to unprotected crossings which are unsafe owing to insufficient visibility and through not being provided with automatic signals.

Consequently, the whole of the problem relative to the equipment at road crossings with railway lines can be summarised under these three points :

I. Over and under bridges;

II. Unguarded level crossings fitted with automatic or fixed signals;

III. Level crossings with gates.

As regards point I, the question of the construction of over and under-bridges, to replace existing level crossings, should be examined from another point of view than that under which it has been examined up to the present.

In view of the methods of signalling the approach of the train at present used, the level crossing should be solely considered as a place on the public road where the traffic is more difficult in certain cases, and not as a more dangerous point than the crossing of one such road with another with heavier traffic.

In the United States, the number of people injured owing to accidents at level crossings only amounted in 1926 to 1.5 % of the total number of people injured and killed in accidents on the roads and road crossings.

We see, therefore, that the problem of safety at level crossings is not so alarming that it should cause us to consent to the heavy expenditure which would be involved in abolishing them.

The replies from the countries who have given us the number of over and under-bridges built since 1926 show that this number represents 1/840th of the total of the crossings of roads with railways and the cost of the replacement of the whole of the existing level crossings by under or over-bridges is, in the United States, calculted at 50 to 75 % of the total value of the railway system.

The result is that the problem as stated under point I will not in the future be a prevailing one and that it will be more a question of choosing between the problems set out under points II and III.

Point II gives a solution which interferes less with the road traffic than that given by point III, the traffic only being stopped at the approach of the train and allowed to continue immediately after the train has passed, whereas the system with keepers closing and opening the gates, should the work be done carelessly, causes the loss of more time.

Mr. Baticle is of the opinion that in the case of level crossings with gates, as a result of the increase of high-speed motor traffic, it would be necessary to appoint more skilled and consequently more expensive staff at the crossing gates, and that the crossings should be fitted with apparatus to warn of the approach of the train.

Consequently, the solution put forward under point II, whether it is a question of fixed signs or automatic signals, will be less costly than the solution under point III.

If, on the other hand, we take into consideration the large number of accidents through the collision of road motors with the crossing gates (84 % in Czechoslovakia and 47 % in Germany), and the necessity for disciplining the road users by requiring them to study the regulations and the precautions to be observed, we see that, from the point of view of safety also, solution II gives better guarantees than solution III.

It is desirable to have it clearly laid down that if signalling at level crossings be required by the regulations, the railway administration is not responsible for accidents occurring at level crossings, any more than the roads administration is responsible as regards accidents occurring at public road crossings.

The replies to our enquiry show that the majority of the railways, following the recommendations of the London Congress and taking into account the above considerations, as well as the necessity for reducing their working costs, have

decided to adopt solution II. However, their efforts in this direction are not coordinated and the installations at level crossings are very varied.

It should be sufficient to mention that Germany, Italy and Jugoslavia having accepted the international decisions to install the St. Andrews Cross signal, this signal has been placed :

In Germany : at all level crossings;

In Italy : at unprotected level crossings;

In Jugoslavia : at level crossings where there were keepers until recently.

This example shows that a signal applied in this way can in the case of an international road user be a source of danger, and at least cease to be understood by him as a warning.

Guided by the above, we have endeavoured to put forward a draft regulation regarding the protection of level crossings, the types of signals and the conditions of visibility, based upon the information supplied and investigated, and we propose it be considered when discussing paragraph 16 of the Summaries put forward in our Special Report.

The President. — I will now ask Mr. Newlands, *Reporter*, if he wishes to add anything to the general lines that Mr. Miszke has put forward.

Mr. Newlands, *Reporter.* — I would like to say that the opinion which interested me most in Mr. Miszke's general opening remarks was that railway companies shoud not be called upon to bear any additional expense at level crossings or elsewhere in the provision of safety for the new form of transport in competition with railways which has grown up on the roads.

Mr. Miszke, if I understand him aright, suggested that we should discuss one or other of the foregoing methods of protection with a view to reaching agreement on a common form of level crossing protection which would be capable of adoption internationally. I do not think that is possible. The points of view of people in various countries are not capable of being consolidated into common agreement — the mentalities of people differ, the requirements of various countries differ, the density of population varies profoundly, and the whole question of crossings differs, and further the stage of development which various countries have reached has a very important bearing on the subject. In old countries, such as Great Britain, France, Germany and many European countries, the problem is not the same problem that has to be faced in newer countries, like North America, United States and Canada. These countries are in process of development even yet, and are a long way behind the old countries in the matter of road facilities that we enjoy in Europe. I put it to you that even in America to-day, the American has had no experience at all with level crossings, the fact being that he never had level crossings of any kind until recently, because he never had roads in the sense that we in Europe have them. The road in America was a « rail » road and the American calls his railway a « railroad » still, for the reason that it is only within the last thirty years that the American is beginning to build roads. Thirty years ago there was only one road in America from New York to Albany along the Hudson River, known as the « King's highway ». I do not believe that America will join us in saying that we believe that level crossings protected by gates are better than open crossings, because America never has had crossings protected by

gates, open crossings are the only ones America has any experience of, and so far as my report goes the total number of crossings amounts to considerably over 100 000 of which 75 % are in North America, Canada and Japan, only 9 % of them being in Great Britain, and I do not think that it is possible for us here definitely to propound an international system for the protection of level crossings, for the reasons I have given.

The President. — I shall now call on M. Betbeder-Matibet, who will take the place of Mr. Baticle, who is unable to attend the Congress.

Mr. Betbeder-Matibet, Ministry of Public Works, France (in French). — Mr. Baticle, the reporter on this question, whom I am replacing without notice has asked me to stress the essential points of his report.

Railways at their inception had an unfavourable reception. They were elbowed out of the way in many directions and the construction and installation of them was made difficult and exacting by reason of statutory restrictions imposed upon them by the various countries in which they were built.

I am, therefore, of opinion that the railways which have fertilized the industrial development of the world for the last hundred years should not suffer any handicap or hardship as the result of the institution and growth of a new competitive form of transport; that competitive form of transport should bear all charges and costs relative to the service it renders in the same way as do the railways.

Level crossings on railways are nothing new. Railways have crossed public roads for a hundred years and, apart from the growth of road traffic, we should not now be considering the question of railway level crossings at all. As a matter of fact, the growth of this new road traffic during the last thirty years is creating dangers and responsibilities to road users that did not exist in the past, and it has obviously become necessary for the protection of the public who use the roads that legislation should be introduced to ensure for all classes of the public a free and safe use of them.

Roads are different from railways in the sense that railways are the private property of the railway companies, while roads are for public service and are maintained at the public expense, and there is no direct responsibility on anyone with regard to assuring the safety of those who use them. There is, however, a very direct responsibility on railway companies in regard to assuring the safety of those who use the railways and special legislation stipulates that the railway companies shall provide such safety measures as are essential to guarantee immunity from danger to those who use the railways.

On these grounds, I am of the opinion that the railway companies should not be called upon to provide at their own expense additional safety measures at level crossings for the protection of any public form of transport on the roads.

Mr. Miszke said three forms of safety measures had been considered, namely: 1) over or under-bridges in substitution for level crossings, obviously one of the best means of dispensing with them; 2) a form of unprotected or open level crossing, with automatic or fixed signals; and 3) a form of level crossing protected by gates.

You must first of all be told that Mr. Baticle is one of the State Inspectors of Railways and that he has in consequence a point of view probably rather different from that of the railway operators; he re-

presents in fact the authority giving the concession, and he handles, if one may say so, the power of the State under the regulations dealing with railways. This explains the rather special point of view that several of you have noticed in the summaries of his report.

Mr. Baticle has been preoccupied above all with the safety of the road users.

It must be recognised, moreover, that in France we take much more care in the case of level crossings of the safety of the road users than of that of the railway, which appears normally to be covered since in fact the railway accidents occurring at level crossings are extremely rare and the railway, it must be recognised, is the stronger of the two.

Consequently the conclusion of Mr. Baticle is that it is necessary to continue to maintain a constant defence against the railways, and in consequence he concludes in favour of the gates.

This opinion is not, I think shared by most of the members of the Section, but in France public opinion is almost unanimously hostile to the suppression of the gates, and it is very difficult for the controlling officers to obtain authority to suppress the gates on lines with little traffic and on roads frequented by few vehicles. These suppressions are the subject of very complicated administrative enquiries, permission being rather difficult to obtain.

This is the reason why we have not been able to conclude in favour of the total suppression of level crossing gates; we can only consider this being done on lines with little railway traffic and at the same time little road traffic. But from this point of view the conclusions of our special reporter are, I think, almost satisfactory since he considers several sorts of protected and of unprotected level crossings.

Another question raised in Mr. Miszke's report is the difficulty the costs of protecting the crossings causes in the railway's accounts. I would like to point out that in France the watching of the crossings is largely done by the wives of the platelayers who live in the level crossings keepers' cottages. Consequently the expenditure is not so great a one that its total suppression should be insisted upon.

The above are some remarks that, I think, I should make at the present time; at the same time I expect to take part in the discussion when considering the different summaries.

The President. — After this general discussion we can now come to the summary and I call upon Mr. Miszke to put forward the first clause of the summary.

Mr. Miszke. — *Article 1 :*

The experience since the London Congress shows that the decisions taken to limit the number of level crossings with keepers have been generally justified.

Mr. Newlands. — I am not very familiar with the findings of the London Congress but I never heard that the conclusion of the London Congress was that we should restrict the number of crossings with keepers. Mr. Miszke, as I understand the first article of his summary, says that it was decided in London to limit the number of level crossings with keepers and that this resolution has been amply justified. I cannot subscribe to that. Mr. Miszke draws attention to what I have already spoken of, the hopelessness of endeavouring to legislate internationally, either at a London Congress or at a Cairo Congress or anywhere else and I challenge the possibility of coming to a conclusion on an international basis.

The President. — Considering the objections made by the English Reporter, would it not be better to eliminate this first summary altogether ?

Mr. Miszke (in French). — The London Congress did not order the limitation of the number of level crossing keepers; it is possible that there was an error in the English translation.

I think it would be better to retain the paragraph with some slight modification.

Mr. Newlands. — I am very much obliged for Mr. Miske's explanation and, if this is so, I withdraw any objection I have made.

The President. — I am of opinion that we might drop the first summary as it is retrospective and historical and would not be very essential to the general conclusions. Do you agree to the deletion of the first of the summaries ?

— A vote is taken and there is a majority in favour of the deletion.

Mr. Miszke. — *Article 2 :*

As, thanks to the use of motor vehicles, road traffic, formerly local, has been transformed into high-speed traffic, over wider areas, and becomes more and more international traffic, the Congress could adopt a motion having as its object to invite the countries belonging to the International Association to introduce uniform legislation and regulations in all countries, dealing with the protection of level crossings, uniform types of automatic and fixed signals and other equipment at the level crossings.

According to the summaries of the London Congress, most countries were then in agreement on this point, but in practice differences were found to exist as regards the distance, and even the colour, so that in short the matter still appears to be rather orderless. It appears then that it is not desirable to be too general, but as concerns the principle itself of protecting the road, this ought to be done.

Mr. Newlands. — I have already expressed my mind with regard to the possibility of uniform legislation and regulations in all countries with regard to protection of level crossings. I have already said I think it is impractical. I submit that to have the same regulations existing with regard to level crossings in Great Britain, France and Denmark as in North and South America is not a practical proposition. The type of protection already differs and is likely to continue to differ. In France and Great Britain for instance we think that the density of population around a crossing, justifies the use of a permanent gate or barrier, the gate or barrier being actually the perpetuation of the fence which encloses the railway from end to end. Many of the new countries, and some of the older ones, do not have fences at all, and it appears to me that where there are no fences there is not the same need for gates at the level crossings, but this is a question for the country concerned. Where, in the older countries, railways are fenced, the fencing is carried across the level crossing and we believe that countries that have approved and authorised that type of protection will not readily scrap it, whatever decision this Congress reaches with regard to any international method of protection.

Mr. Betbeder-Matibet (in French). — I would accept the text of summary 2 with certain alterations of the wording. I suggest first of all that the word : « legislation » be suppressed, this being likely to be in my opinion a difficulty in the way

of application; actually the Government of each country is as a rule authorised to issue regulations; the drawing up of « legislation » requires on the other hand the agreement of the Parliament, which is not always disposed to vote the laws put before it.

I propose therefore to say : « ... to lay down regulations... » this being within the function of the executive powers.

As regards road signalling, a certain number of road signals of uniform design and especially at level crossings have in practice been adopted. Everyone is familiar with the triangular bords showing a locomotive and its smoke, and in this sense I associate myself particularly to the vote of summary 2.

I would also be pleased to see the final phrase of this article modified : « ... and other equipment at level crossings... » This is equipment which only interests the domestic organisation of the railway and does not concern the road users. Consequently I consider that it has no immediate interest for the latter.

Mr. Hossu, Rumanian Railways (in German). — I propose that paragraph 2 of the summaries be accepted with a slight modification. Contrary to the proposal made by Mr. Betbeder-Matibet to cut out the word « legislation », I am of the opinion that this word should be retained. The law lays down the method of protecting level crossings : by gates, by signals, or by any other method. This is the reason why I wish to retain the word « legislation ». I would like the wording to be : « to introduce in all countries the Administrations of which belong to the International Railway Congress Association uniform legislation and regulations dealing with the protection of level crossings ». I ask that the word « legislation » should not be cut out; it would be better to say : « legislation based on uniform principles ». This method could be adopted in all coutries.

Mr. Betbeder-Matibet (in French). — Seeing that the difficulty of drawing up a proper wording appears to be holding the attention of the Section, I propose a new wording on the following principles :

It is necessary above all to obtain uniformity in the signals affecting road users.

This principle being granted, I think that it would be possible to adopt a motion having as its object the use in the countries belonging to the Association, of uniform types of automatic and fixed signals and other devices affecting the road users.

Under this form we avoid, in practice, the objection that I myself made as regards the legislative intervention, and even the intervention by regulation which also presents certain difficulties.

Every Government will appreciate, according to the conditions of its railway regime, the arrangements that it has to make in its own country. But what should interest the Congress above all is the adoption of uniform types of signals and uniformity of all indications intended to call the attention of the road users to the danger to which they are exposed.

As I have already said, the International Roads Commission has already standardised a large number of signals affecting road traffic. It would continue in this direction as regards winking lights, for example, which signals have been considered in the report.

Mr. Driessen, Netherlands Railways (in French). — I am in entire agreement with the modification proposed by Mr. Betbeder-Matibet. In addition, I should like to see the scope of the summaries enlarged, as this only addresses itself to the

countries and railway administrations belonging to our Association. It appears to me better to give this summary a more general field of application by extending it to all the countries of the world, if possible, seeing that we are drawing up general conclusions resulting from a careful investigation which could be adapted to all countries.

I propose, therefore, to draw up the summary in this sense, whilst at the same time adopting the amendement proposed by Mr. Betbeder-Matibet.

Mr. Hossu (in German). — As it is a question of the forms of the signals and other safety devices, I propose to underline the second point.

It says : « uniform legislation and regulations » in connection with safety. The solution relative to types is uniform. It is possible to arrive at this more easily, but the principle is to establish regulations and legislation determining how the level crossings ought to be protected, whether by gates or other methods, or if they should be left unprotected.

Legislation and regulations prescribing the method of protection to be used must be introduced. The protection of level crossings should be laid down by legislation and by regulations based on uniform principles. I propose therefore the following text : « The Congress invites all countries to institute legislation and regulations based on uniform principles as regards the protection of level crossings, and to adopt uniform types of fixed and automatic signals and other devices affecting the road users. »

Mr. Driessen (in French). — I would like to point out that what concerns the road users is not the principles but the signals. The thing that ought to be uniform is that which the motorists meet on the roads. Consequently the signals actually seen are what is important and these should be uniform and not the principles. This is the reason why I cannot agree with the opinion of the Rumanian representative.

I consider that we could still further simplify summary 2 and adopt a text approved by all by saying that the Congress invites all countries to use uniform signals at level crossings.

Mr. Newlands. — I think that we have very nearly reached an agreement. All that is difficult is the matter of drafting clauses. I agree that Mr. Betbeder-Matibet's recommendation be accepted, but in view of some amendment I have been considering whether we could not still further simplify the clause and make it : « That the Congress adopt a motion to invite all countries to introduce uniform types of road signals at railway level crossings », and rule the question of whether they are automatic or fixed and the question of other equipment out of court at this stage.

The President. — Would Mr. Betbeder-Matibet agree that we say that the Congress « should invite all countries to introduce uniform types of road signals at level crossings », not « to adopt the motion », as this might lead to further discusssion.

Dr. Tanaka (Department of Railways, Japan). — I draw your attention to the difference between railway and highway or roadway : therefore in this case the Railway Association and the Road Association should be consulted, the object of protection being a question of road traffic. I therefore think it is better to make a difference between the Railway

Association and the International Road Association.

Mr. Betbeder-Matibet (in French). — I also think that collaboration is required between the International Road Commission and the Railway Congress in order to arrive at uniform results and to achieve something practical in the common interest.

As Mr. Driessen has just said, the road user requires a material signal having a given form and specified meaning, the rules according to which such or such types of signal shall be placed being, as far as he is concerned, of secondary importance.

Mr. Czapski, Ministry of Communications, Poland (in French). — As concerns the different proposals before us, I think that that made by Mr. Hossu is more complete than that of Mr. Betbeder-Matibet in so much as it also takes into account the circumstances under which the signals shall be used.

I think that the experience we have as regards uniformity of requirements relative to international railway traffic, show that it is not impossible to arrive at some regulations within wider limits. For this reason, I suggest that the proposal put forward by Mr. Hossu be accepted.

Mr. Miszke (in French). — We therefore have before us two texts submitted for the vote of the Section. The first is that proposed by Mr. Betbeder-Matibet and approved by several other delegates with certain modifications :

As, thanks to the use of motor vehicles, road traffic, formerly local, has been transformed into high-speed traffic, over wider areas, and becomes more and more international traffic, the Congress invites all countries to introduce uniform legislation and regulations dealing with the protection of level crossings, uniform types of automatic and fixed signals and other equipment at the level crossings.

The second proposed by the Rumanian delegate, Mr. Hossu, begins in the same way but continues as follows : « invites all countries to adopt legislation and regulations based on uniform principles and to adopt uniform types of automatic and fixed signals at level crossings for the protection of the traffic. »

Mr. Besser, Ministry of Communications, Germany (in German). — May I propose an amendment to the text recommended by the Rumanian delegate ? We ought to say : « The Congress invites all countries to endeavour to introduce uniform regulations for the protection of level crossings, and in particular the use of uniform types of signals, whether moveable or fixed. »

Mr. Hossu (in German). — I am prepared to accept this proposition. I suggested measures of legislation and regulation to be in agreement with the text of the Special Reporter. But as objections have been made I will accept the following text : « the Congress invites all countries to adopt uniform regulations for the protection of level crossings and, in particular, the use of uniform types of automatic and fixed signals. »

The President. — There have been two strong expressions of opinion : One by Mr. Betbeder-Matibet, aiming at the adoption of uniform types of signals, and another by Mr. Hossu, favouring the introduction of uniform regulations and signals. I put these proposals to the vote of the Meeting.

— In favour of Mr. Betbeder-Matibet's proposal — 15; in favour of second resolution, by Mr. Hossu — 16.

The President. — In view of this vote the following is the definitive text suggested for the summary :

« As thanks to the use of motor vehicles, road traffic, formerly local, has been transformed into high-speed traffic and becomes more and more international, the Congress invites all countries to adopt legislation and regulations inspired by uniform principles relating to the protection of level crossings and the types of signals. » *(Adopted.)*

— The discussion will be continued tomorrow, and the meeting will now adjourn.

Meeting held on the 21 January 1933.

Mr. D. VICKERS IN THE CHAIR.

The President. — We shall now resume the discussion on Question I.

I call upon Mr. Miszke, *Special Reporter.*

Mr. Miszke. — *Article 3 :*

The most effective solution as regards the crossings of the roads with the railways, the construction of over and under-passages, can only be applied in limited cases to crossings of roads with very heavy traffic with main line railways.

This solution cannot be taken into consideration as a more or less general rule in view of the exhorbitant cost it would involve.

The President. — Does any member wish to make any observations on summary 3.

Mr. Hossu (in German). — I propose a slight modification of paragraph 3. Instead of « can only be applied in limited cases », I would say : » can only be demanded in limited cases at crossings of roads with very heavy traffic with main line railways. »

Mr. Betbeder-Matibet (in French). — I propose to put « carried out ».

The President. — We shall say « carried out ». No further objections being raised, Clause 3 will be taken as adopted as No. 2, with this slight alteration.

Mr. Miszke. — *Article 4 :*

In the case of level crossings where the road traffic is of average intensity, it is desirable to considerer that the automatic or fixed signals give a degree of protection which is not inferior to that given by the gates and have this advantage that they interfere less with the road traffic and prevent the accidents resulting from collisions with the gates, so frequently reported.

If the signalling of level crossings is required by the law it should be clearly laid down that the Railway Administration is not responsible for accidents occurring at level crossings, in the same way as the Road Administration is not responsible for accidents occurring at crossings of public roads.

Mr. Tettelin, Nord Railway, France (in French). — This article is, in my opinion, the principal point of the question

under discussion. It seems to me, however, that when it is a question of forming an opinion on the choice to be made between the use of gates and the use of automatic or fixed signals for the protection of level crossings without any other justification than that given in the text proposed, there are perhaps not many arguments for adopting it.

The reporters have collected very important information and results, which Mr. Miszke has summarised for us with much care, and I think that it would be useful to complete the summary formulated in this paragraph by describing briefly the practice of the different countries.

This should be quite easy as Mr. Miszke has given us the information in his report.

The summary I propose to put before you on this subject would be worded as follows :

« In the *United States* the number of guarded level crossings is diminishing : in 1927 it was only 5 957 out of a total of 232 000 level crossings. In certain States the gates are not considered as satisfactory fast road traffic and they are replaced by *written notices*, *flashing signs* or by *keepers* on the site, who stop the road cars when a train arrives.

« In *Europe*, on the contrary, there are methods still in use which relate to times when the road traffic was quite different from the present. Efforts are now made to announce the arrival of trains at guarded level crossings with heavy traffic on either railway or road and in case of insufficient visibility toward the railway. The suppression of gates would, however, signify a progress because the halts on the road would be reduced to a minimum and the risk of accidents caused by closed gates independently of the passage of trains, would be eliminated.

« Following these ideas, and in accordance with the American practice (State of New York) the level crossings can be classified into three groups :

« I. Unguarded level crossings without gates and without automatic signalling of the arrival of trains.

« II. Unguarded level crossings without gates but with automatic signalling of the arrival of trains.

« III Guarded level crossings with or without gates.

« The first category involves the level crossings where the visibility on the railway is good and where the number of trains per day does not exceed 100 and the product of the number of trains multiplied by that of the road vehicles is under 70 000, as well as the level crossings with insufficient visibility, limited rail traffic and light circulation on the road.

« The second category involves level crossings where the visibility on the railway is not sufficient and where the other conditions are fulfilled.

« The third category involves other level crossings with heavier traffic. The most important among these are generally replaced by over or under-passages. »

I should like to point out that, in principle, the absence of gates seems to be a desirable progress, but in fact it calls for discipline on the part of the road users.

Such discipline is not acquired all at once, between one day and another, in every country. In my opinion each country should decide when it can with safety undertake the suppression of level crossing gates and their replacement by signals.

The summary of the actual situation, brought to the notice of all the governments, would enable each of them to reflect on this matter with profit.

The President. — Mr. Tettelin proposes that we should add to these various summaries a statement of the conditions and practices which prevail in the United States, and he makes this suggestion because he thinks that it would lead to the summaries of the Congress being more easily accepted by the Administrations of the Railways and Public Authorities if they had it in concise form and had not to read through the reports.

Mr. Miszke (in French). — Mr. Tettelin's observations are given in the reports. I consider they could be inserted in our summaries with profit, provided they are slightly rearranged.

The proposals Nos. 1 and 2 could be inserted between summaries 3 and 4, and the last between summaries 11 and 12.

Mr. Tettelin (in French). — I agree to the secretariat rewording my proposals before they are submitted to the full meeting for approval.

Mr. Betbeder-Matibet (in French). — I would prefer the vote on summary 4 to be deferred until the wording has been agreed by Mr. Miszke, in view of the remarks of Mr. Tettelin.

In addition I have a personal remark to make as regards the second paragraph of summary 4. In the latter mention is made of the responsibility of the railway administrations. Now, the Congress in my opinion has no authority to decide questions of responsibility. These, unless I am mistaken, are a matter for the judicial authorities. The principle, moreover, on which the railway administration is based is rather difficult to appreciate, as the railway administration is at the same time the owner of the track and the operator of the vehicle, whereas on the other hand, the State is the owner of the public road, and the individual, the user, is the owner of the vehicle. There is therefore an important difference as well in fact as from the legal point of view.

I propose therefore that this paragraph be deleted from summary 4.

Mr Level, Compagnie générale des Voies ferrées d'intérêt local, France (in French). — Gentlemen, I had no intention of speaking upon this question, but the opinion expressed by Mr. Betbeder-Matibet has led me to intervene seeing that we, as operators, do not see the question from the same angle as the Government representative.

Yesterday Mr. Betbeder-Matibet told us that the inspecting officer considers it above all necessary, as far as level crossings are concerned, to protect the motor against the railway.

So far as I am concerned, I do not think that the question should be considered from this point of view. It is solely a question of endeavouring to find, loyally, quietly, and carefully, the way in which to endeavour to avoid accidents. It is not a question of protecting one against the other. It is a question of assuring purely and simply, as far as possible, safety. And from this point of view I do not agree with Mr. Betbeder-Matibet when he asks for the second paragraph of summary 4 to be deleted.

It is obvious in my opinion that this article is important, seeing that we are endeavouring to find the measures of protection to be taken at level crossings : consequently when these measures have been applied it should be clearly understood that the railway company has taken these precautions and cannot be held responsible, so that, so far as we are concerned, I do not ask for this part to be

suppressed, but that it should be slightly modified.

As regards the beginning of the second paragraph : « It should be clearly laid down » I would like to ask the question : who does the Reporter think should clearly lay it down ? I think that we are all in agreement that this is obvious, and I suggest rather: « It must be understood » so that no one can charge us with wishing to lay down the law; we are not, in the Congress, expected to draw up any legislation, but to present observations and we are quite in order, I think, in stating that when we have done our duty, i. e. when we have provided for the road sufficient protective measures, there can be no question of holding us responsible for accidents which are due most often to the folly of certain drivers.

To sum up, I insist that this paragraph should be maintained with the slight alteration that I have suggested.

The President. — Do you agree with this alteration, Mr. Betbeder-Matibet ?

Mr. Betbeder-Matibet. — No, Sir, I must maintain my point of view.

Mr. Newlands. — I have a little difficulty in understanding the point that is being discussed, owing to my lack of knowledge of any language other than English, but I gather that a suggestion has been made that the protection of level crossings by automatic and fixed signals is better than by gates and barriers. Is that so? If it be contended that automatic and fixed signals is a better form of protection than gates and barriers then I wish emphatically to dissent. I base my opnion on my experience in Great Britain which is possibly one of the most densely populated countries in the world and it is a country which is more intersected by good roads and good railways having regard to its size, than almost any other country. Now, my experience with regard to accidents arising at level crossings, as compared with the extent of similar accidents in America, which is a new country and has not the road mileage we have in Great Britain having regard to population — either road mileage or railway mileage — is that these accidents are steadily diminishing in the last six years. I need not trouble you with a whole lot of figures but I would say that the number of persons killed in the U. S. A. per 10 000 vehicles licensed to run on the roads was 0.64 in 1930, while the corresponding figure in Great Britain was only 0.05 or one twelfth of the figure in the U. S. A. The striking aspect of the figures is that in Great Britain we have railway crossing protection in the form of gates, while in America it is in the form of fixed or automatic signalling, and therefore I hold that the gate is a far more effective protection than fixed or automatic signals. In great Britain the number of people killed on the road is about 6 000 per annum. In 1929, when 5 906 were killed, only 16 of these represented fatalities at level crossings. For 1929, therefore, the proportion of people killed throughout the country was 27.6 persons per 10 000 motor vehicles licensed, while the fatalities at level crossings were only 0.08 per 10 000 vehicles. I am giving you these figures with the intention of showing to you that we may very readily enter upon a dangerous field if we jump to conclusions too readily with regard to what is and what is not the best form of protection for level crossings. I submit that our experience in Great Britain, as compared with America, is a very fair means of showing up the advantages and disadvantages of the two kinds of protection —

protection by gates or barriers and protection by fixed or automatic signals, and I hope I have shown you from these figures that the gate form of protection seems to be preeminently the best.

Mr. Driessen (in French). — It appears to me, Mr. President, that we have not made sufficient distinction between the different elements : in summary 4 we have put on the same plane automatic and fixed signals. It appears to me that this is not right, as what occurs when a motor car approaches a level crossing — and in general we can consider motor cars alone as other vehicles and pedestrians can quite easily look after their own safety — while the motor approaches the level crossing two things are in question : first of all to see that a level crossing is being approached, and secondly to see if the level crossing is protected or if a train is approaching.

To see when one is approaching a level crossing a fixed signal is all that is necessary.

To see if a train is approaching, there must be either sufficient visibility, or an automatic signal. The automatic signal does not make it possible to see the train but it warns that the train is close to the level crossing.

It is therefore not right in my opinion to put the automatic and fixed signals on the same footing.

Finally, I think that the intensity of traffic to a certain extent — whilst recognising that there are lines on which the number of trains is such that it is not possible to think of unprotected level crossings — is not an element which can be brought into the discussion. With a traffic of one train every half hour the gate could quite well be suppressed.

We have in Holland, on electrified lines, unprotected level crossings. There is at least one train every quarter of an hour on one of the two tracks and it is very interesting to record that on these lines no accidents have occurred.

I would propose certain modifications in the sense of my remarks and I ask that summaries 5, 6 and 7 should be discussed together.

I would prefer that summaries 6 and 7 should be suppressed and that the beginning of summary 4 should be worded as follows :

« In the case of level crossings where the road traffic is of average intensity... », seeing that in Clause 8 it is stated that « The gates should be retained at crossings with very heavy traffic on the road and on the railway... » We might say : « In the case of level crossings where the road traffic is of average intensity, it is desirable to consider that automatic... signals... » and delete « and fixed ». On the other hand, I propose to add to the first paragraph of Clause 4: « they may, therefore, also be used instead of gates at crossings where visibility is poor ».

The President. — Do you propose a completely new wording ?

Mr. Driessen (in French). — No, these are simple modifications that I am proposing, as, in my opinion, they would enable us to delete summaries 6 and 7.

Mr. Jourdain, Ch. de fer Secondaires du Nord-Est, France (in French). — I object to the suppression of the words : « or fixed » in summary 4.

Actually, the wording which we have to draw up today applies quite as much to the secondary railways as to the main lines.

Now, it would be quite wrong, on lines where only three trains in each direction

are run each day, to provide all level crossings with automatic signals.

It appears to me, on the contrary, that summary 4 was very well worded with regard to the first paragraph now being discussed.

I think that it would perhaps be as well to rearrange summaries 6 and 7 so as to make them more precise and to avoid an apparent contradiction which exists in the text before us.

In fact in paragraph 6 it is stated : « In the case of insufficiently good visibility, in place of fixed signs, the automatic signalling of the approach of the train should be introduced. »

This destroys to some extent summary 7, but there may be some confusion on this subject and it appears to me very desirable to merge summaries 6 and 7 into one summary.

We could say, for example : « In the case of insufficient visibility, in place of fixed signs, automatic signalling of the approach of trains should be introduced; however, fixed signs may be adopted as good enough when... »

In the name of the French secondary railways I protest against the suppression in the first paragraph of summary 4 of the words : « or fixed ».

The President. — This summary has caused so much discussion that I think the only way is to go through it carefully and put the various modifications to the vote.

Mr. Newlands. — Dealing with the point raised by Mr. Miszke, which is in the second line of summary 4, I take exception to the words, « average intensity ». I object to these words because I do not think they mean anything. What I think is intended is, « light road traffic » and the summary should be altered to read : « In the case of level crossings where there is light road traffic it is desirable to consider that the automatic or fixed signals may give a degree of protection which is not inferior to that given by gates... ». I would point out that, even in Great Britain, we are quite content to accept automatic or fixed signals without gates on roads having light traffic, which are crossed by railways. It is on the heavy lines we wish to have gate protection and I think this is one of the best instances possible of the danger of jumping to hasty conclusions with regard to road and rail traffic which vary in a very wide range in different countries. In Great Britain we have two types of road protection — on the light railway and road, we have no gates but on heavy road and rail traffic we insist on gates and, we think, rightly.

Mr. Miszke (in French). — Mr. Newlands proposes therefore to replace in summary 4 « average intensity » by « low intensity »; under these conditions we might have level crossings without gates only at points with very little traffic and we should be in contradiction with the summaries of the London Congress. The proposal of the Special Reporter was that it would be possible to abolish crossing keepers only at level crossings where the traffic was very light. But after discussion, the text of the Special Reporter was altered so as to recommend that level crossing keepers should be abolished « except on railways with exceptionally heavy traffic ».

Mr. Jourdain (in French). — It seems to me that it would be better to leave the text to read : « is of average intensity » and say : « it is desirable to consider that an appropriate signalling ... » instead of

« it is desirable to consider that automatic or fixed signals... »

Mr. Driessen (in French). — Mr. President, I am quite in agreement with the modification suggested by Mr. Jourdain, which I support.

Mr. Fiori, Permanent Commission of the Association (in French). — In the name of the Italian railways I also agree with the proposal made by Mr. Jourdain in order to maintain the wording: « average intensity » and to add : « appropriate signalling. »

The President. — M. Miszke does not accept your suggestion because he thinks it would be against the summary adopted at the London Congress if other words were used. Besides, Messrs. Jourdain and Fiori suggest that the words « average intensity » should be retained and the words « automatic or fixed signals » deleted and replaced by « appropriate signalling ».

Mr. Newlands. — I have nothing to say, but the word « average » has a very different meaning in English.

The President. — Do you insist ?

Mr. Newlands. — No, the Meeting is against me.

The President. — The Meeting has still to decide whether the alterations proposed by Messrs. Jourdain and Fiori are to be retained, i. e. replace the words « fixed and automatic signals » by « an appropriate signalling ». I shall ask the Principal Secretary, Mr. Duchateau, to read the proposed wording.

Mr. Duchateau, *Principal Secretary.* — The new text would be as follows : In the case of level crossings where the road traffic is of average intensity, it is desirable to consider that an appropriate signalling gives a degree of protection which is not inferior to that given by the gates and has this advantage that it interferes less with the road traffic and prevents the accidents resulting from collisions with the gates, so frequently reported.

Mr. Level (in French). — I think it is desirable to maintain the idea of traffic on the railway and on the road. For this reason I would like the text proposed by Mr. Miszke : « where the road traffic is of average intensity » to be maintained without being too precise; it is not solely a question of the road but of the traffic taken in the general sense both on the railway and on the road.

Mr. Driessen (in French). — Mr. President, I do not agree with this proposal as when it is a question for example of a railway line on which there are 2 or 3 trains a day and where the road traffic is very intense, it would naturally be necessary to provide gates.

The President. — In order to come to an agreement as regards the text of article 4, I suggest that we first vote on the retention or deletion of the word « road ».

— The majority of the delegates favours deletion of this word, the text becoming « where the traffic is... »

Mr. Miszke (in French). — For my part, I have no objection to raise as regards the substitution of *appropriate signalling* for *automatic or fixed signals.*

— When put to the vote by the President, this alteration was approved.

The President. — We have now to consider Mr. Tettelin's proposal to add to

the conclusions the commentary which he read to us just now.

Mr. Miszke (in French). — In order to meet Mr. Tettelin's request, we might make summary 4 into summary 5 and take as summary 4 the first part of the proposal of Mr. Tettelin up to and including : « the suppression of the gates would however signify... »; the other part would be better placed after summary 12. We would then add between summaries 3 and 4 the following :

« In the *United States* the number of guarded level crossings is diminishing : in 1927 it was only 5 957 out of a total of 232 000 level crossings. In certain States the gates are not considered as satisfactory for fast road traffic and they are replaced by *written notices, flashing signs* or by a *keeper* on the site, who stops the road cars when a train arrives.

« In *Europe*, on the contrary, there are methods still in use which relate to times when the road traffic was quite different from the present. Efforts are now made to announce the arrival of trains at guarded level crossings with heavy traffic on either railway or road and in case of insufficient visibility towards the railway. The suppression of gates would, however, signify a progress because the halts on the road would be reduced to a minimum and the risk of accidents caused by closed gates independently of the passage of trains would be eliminated. » For my part I agree to the addition of this commentary.

The President. — It is a question of adding something which is not a conclusion, but a statement — really a summary of the conditions existing in different countries.

Mr. Duchateau (in French). — Mr. Tettelin, do you not think that this would make the wording of the summaries too heavy ? Would it not be possible to word this justification in two or three lines ?

Mr. Tettelin (in French). — This is what Mr. Miszke endeavoured to do.

The President. — I put to the vote Mr. Tettelin's proposal to add this statement to the conclusions proposed.

— The insertion of this remark between summaries 3 and 4 was approved by 16 votes against 6

Mr. Betbeder-Matibet (in French). — I would like to bring up my proposal to cut out part of the second paragraph of the old summary 4.

The President. — I ask you to vote on the proposal of Mr. Betbeder-Matibet.

— As there were 8 votes for the proposal and 12 against it, it was rejected.

Mr. Miszke (in French). — It was also suggested that it should read : « It must be well understood » instead of : « it should be clearly laid down. »

— This alteration was adopted.

The President. — We will now take summary 5.

Mr. Miszke read the summary worded as follows :

Fixed signs in the form of a St. Andrew's cross preceded in the case of roads over which the road motor circulation is heavy, by an advanced warning sign, should be considered as sufficient protection so long as the visibility is good enough.

The President. — Does everyone agree to accept summary 5 ?

— Summary 5 was adopted.

We will now take summaries 6 and 7.

Mr. Miszke. — These summaries are worded as follows :

6. In the case of insufficiently good visibility, in place of fixed signs, the automatic signalling of the approach of the train should be introduced.

7. Fixed signs can also be placed at level crossings with inadequate visibility, if the railway traffic is limited as regards speed and the road traffic is not very heavy.

The President. — I propose that we discuss summaries 6 and 7 together.

Does anybody wish to alter the wording of these two summaries ?

Mr. Miszke. — I am of the opinion that they should be maintained as they are.

The President. — In the case of the French text it has been proposed that the words « il faudra adopter » be replaced by the words « il serait recommandable d'adopter ». In the English translation the words are : « should be ».

Mr. Newlands. — I suggest the word « may » instead of the word « should » in summary 6.

Mr. Miszke. — It is in fact optional.

Mr. Betbeder-Matibet (in French). — In France we would say : « il conviendrait. »

Mr. Bouteloup, Midi Railway, France (in French). — I propose to invert the order of the summaries 6 and 7. It seems to me that clearness and good order of the ideas would be improved.

Paragraph 5 considers the case of sufficient visibility, whatever may be the importance of the two traffics. Paragraphs 6 and 7 deal on the contrary with the case of « insufficient visibility »; if one of the two traffics is small, a simpler form of signalling would meet requirements, but if the two traffics are intense, an improved form of signalling is desirable.

Summary 5 would remain as it has just been approved, but I suggest the following wording for summaries 6 and 7 :

Summary 6 : « In case of insufficient visibility — taking into account the speed of trains — fixed signs are good enough where the number of trains is limited and the road traffic is not heavy. »

Summary 7 : « But if in this case of insufficient visibility both traffics are heavy, automatic signalling may be recommended. »

Mr. Miszke (in French). — I am in agreement with the new wording of summaries 6 and 7, but I should prefer to say in summary 6 : « railway traffic the speed of which is limited. »

Mr. Bouteloup (in French). — I do not agree.

None amongst us considers that the slow speed of a train is a practical method of stopping in the case of a coach or motor car passing over the crossing. The speed would have to be so slow that it could not be worked to in practice. A single factor is important as regards the speed : that is the visibility.

When analysing the reports presented on the question we find that the general demand is that the crossing should be visible for 15, 18 or 20 seconds. This is a period of visibility sufficient to allow the vehicles to pass, but the fact that the train is running fast or not has no other interest than this.

This is the reason why I intentionally proposed to alter the wording.

The President. — We adopt therefore summaries 6 and 7 in the inverted order, and with the slight modifications made thereto.

We will now take summary 8.

The gates should be retained at crossings with very heavy traffic on the road and on the railway, when the automatic signalling is not sufficient, and when keepers and the regulation of the road traffic appear to be necessary.

The President. — Has anyone any remark to make upon this summary ?

Mr. Newlands. — I approve except that I think the word « very » should be deleted.

Mr. Miszke. — I consider the text should remain as drawn up.

Mr. Herwig, Deutsche Reichsbahn Gesellschaft (in German). — The text of summary 8 is likely to suggest an unexpected criticism of automatic signalling.

I suggest in consequence that the words « automatic signalling » be left out and that the text be worded somewhat as follows :

« The gates should be retained only at level crossings at which the road and rail traffic is very intense, where the railway line cannot be kept clear of the road traffic except by an *effective gate* and where level crossing keepers appear necessary ».

The President. — This is equivalent to saying : « When safety can only be assured by means of crossing gates. »

Mr. Miszke (in French). — Under these conditions, I think that the delegate of the German Railways would accept our text if everything relative to automatic signals was deleted.

Mr. Tettelin (in French). — What change is it desired to make to the original text ?

Mr. Miszke (in French). — It is suggested we cut out the paragraph after the mention : « When the automatic signalling is not sufficient » and replace this by « when the railway should be kept clear of the road traffic ».

Mr. Schutz, Section Secretary. — The meaning of Mr. Herwig's proposal is : « When the road traffic is completely separated from the railway traffic », by a gate for example.

Mr. Tettelin. — Should the gates be retained in this case ?

Mr. Miszke. — Yes.

Mr. Bouteloup. — What would be the result of this alteration of the text ?

Mr. Miszke. — It would not allow automatic signalling.

The President. — I will submit to the members of the Section the summary such as drawn up in the special report of Mr. Miszke, and after that I will put to the vote the alteration suggested by Mr. Herwig.

— The majority declared itself in favour of the summary being retained as given in the special report.

The President. — Let us now take summary 9.

Mr. Miszke. — *Summary 9 :*

In the case of such level crossings, the

crossings keepers should be recuited from qualified staff and the crossings should be, as far as possible, well lighted.

These are the ideas of Mr. Baticle; I would alter the beginning as follows : « On level crossings with very heavy traffic... »

The President. — Is there any objection to this summary ?

Mr. Tettelin (In French). — I ask that this paragraph be suppressed. In it is said: « In the case of such level crossings, the keepers should be recruited from qualified staff »; this might suggest that the other level crossings can recruit staff not qualified, i. e. men none too capable of carrying out their duties. I think therefore is is better to say nothing at all. *(Laughter.)*

The President. — Is everyone in agreement to cut out this summary ?

— The summary was then suppressed.

The President. — We will now take summary 10.

Mr. Miszke. — *Summary 10 :*

It is important that the work of the keepers should be facilitated by the trains being announced to them by the neighbouring signal boxes if they are near enough, or by a system of automatic signals.

Mr Betbeder-Matibet (in French). — I think that the principle of giving warning of the approach of trains at level crossings as carried out on the Alsace-Lorraine Railways is a good one, and that it should be made general. I wouldt not oppose however any possible modification of the summary.

Mr. Jourdain (in French). — I suggest, Mr. President, that we alter the word « important » because in practice gates would be retained on secondary lines as well and the installation of automatic warning signals on these lines would be too costly. I suggest that we state : « It is recommended to... »

Mr. Tettelin (in French). — I propose to say : « It is sometimes necessary to make the work of the keepers easier. »

Mr. Betbeder-Matibet (in French). — Or : « In some cases it may be desirable that the work of the keepers should be facilitated » or « is facilitated. »

The President. — I suggest that summary 10 be adopted beginning with the words : « It is recommended to facilitate... » *(Approved.)*

I will now ask Mr. Miszke to read summary 11.

Mr. Miszke. — *Summary 11 :*

To increase the visibility of the signs and of the gates they should be painted in white and red stripes so as to make them more striking to the eye and they should also as far as possible be fitted with cats's eye reflectors.

Mr. Newlands. — I suggest that the words « white and red » before the word « stripes » be deleted and the word « conspicuous » substituted. I do not think it is for us to prescribe colours.

The President. — There appears to be some desire for uniformty.

Mr. Newlands. — I should like to say that with my considerable experience of colours I find white and red the most unsuitable. In England a considerable number of the houses are red and also red and white merge into pink at a dis-

tance and are most unsuitable for road signs. I strongly urge that the word « stripes » only should be used and each country choose its own colours.

Mr. Betbeder-Matibet (in French). — Would it not be possible to say : « in alternating bands... » or « of alternating colours ».

The President. — Yes.

Mr. Betbeder-Matibet (in French). — I would like however to remark that red and white are the colours which give the most striking and most visible optical contrast.

The President. — We have heard the opposite opinion of Mr. Newlands who said that at a distance these two colours mix and only result in a pink colour.

Mr. Betbeder-Matibet. — I do not insist.

The President. — I suggest therefore that the summary be adopted, suppressing the words : « white and red » and replacing them by « two colours alternately ». *(Approved.)*

Mr. Miszke. — *Summary 12 :*

In view of the fact, on the one hand that the organisation of protection on the above lines might be very costly, and the construction of over and under-passages would be even more so, and futhermore that the road motor traffic at high speed does not select the shortest road, but rather a good one even if longer, and that consequently the road traffic is concentrated on a restricted number of level crossings, an endeavour should be made to reduce as much as possible the number of road crossings with the railways by abolishing level crossings with little traffic, by diverting the traffic towards those which, having a heavier road traffic, are fitted with adequate signalling systems and warning devices or gates, and by building under and over-passages at the places where the heaviest road traffic is concentrated. When drawing up shemes for building and rebuilding the roads, these circumstances should be taken into account.

The President. — Has anyone any objections to raise to summary 12 ?

As no one wishes to speak on this summary, we will consider it as adopted and now take summary 13 of the special report.

Mr. Miszke. — *Summary 13 :*

As the increase of the difficulties at level crossings has been caused by the formerly unknown intensity of the road traffic, the road should assume the cost of constructing the over and under-passages as well as those for the additional protection of the crossings required by the growth of the road traffic.

— As no objection is made to this summary, it is *adopted.*

Mr. Miszke. — *Summary 14 :*

It should be recognised that the realisation and maintenance of the conditions of visibility, governed by uniform regulations for level crossings in all countries, are of very great importance. The regulations should therefore be drawn up accordingly.

Mr. Betbeder-Matibet (in French). — I think that summay 14 repeats the one we so fully discussed yesterday morning. Do you not think so Mr. Miszke ?

Mr. Miszke (in French). — This is not my opinion seeing that in summary 2 it is a question of signalling, whereas here it is a question of visibility.

Dr. Tanaka, Japanese Government Rail-

ways. — I object to the words « all countries ».

Mr. Tettelin (in French). — I suggest that summary 14 be suppressed because to some extent it is included in summary 2, and in addition because visibility is a local question which each railway has to determine according to the site, the speed, and the nature of the traffic, and that there is no need to legislate throughout the whole of the world so as to arrive at uniform regulations in very widely differing cases.

I should like therefore to see summary 14 suppressed, seeing that its substance is already implicitly included in summary 2.

Mr. Miszke (in French). — There are some countries where the regulations allow the railways to see that there is proper visibility even on land belonging to private owners, and this paragraph considers therefore regulations enabling the visibility to be maintained.

Mr. Betbeder-Matibet (in French). — The precisions which the Special Reporter has just made are interesting; it is a question therefore of giving the road authority the right to keep the approaches of a level crossing clear so as to assure that the visibility is good. But the question stated in this way is one of road legislation which is the object of legislative measures in each State.

It would however be difficult, I think, to obtain uniform regulations in all countries, and for this reason I agree with Mr. Tettelin's suggestion to suppress this summary.

Mr. Newlands. — I consider that the words « uniform regulations for level crossings » should come out.

The President. — Should we suppress the summary altogether ?

Mr. Hossu (in German). — I would prefer summary 14 to be retained with a slight modification as follows :

« It must be recognised that it is very important that the requirements regarding visibility should be drawn up on uniform principles ».

Mr. Tettelin. — This is not evident.

Dr. Tanaka. — I also consider that the conditions in the different countries are very different.

The President. — We have therefore two, if not three different proposals before us : the complete suppression of the summary, or its retention with certain modifications or not.

I will begin by taking a vote on the question of suppressing the summary altogether.

— The vote was in favour of summary 14 being suppressed.

We will now take summary 15 :

At level crossings without keepers, which are very visible or are provided with automatic signalling, the speed of the road traffic should be limited to 25 km. (15 miles) per hour; at crossings with inadequate visibility, and not fitted with automatic signalling, the vehicles should be required to stop.

In both cases these arrangements should be made known to the public by notices attached to the signs.

My proposal tends in fact to prescribe a reasonable speed, such as 25 km. (15 miles), in the case of level crossings which are clearly visible and fitted with

signals, and to stop if the visibility is not good and there are no signals.

Mr. Tettelin (in French). — I should like to remark that summary 15 in certain countries, especially in France, would be unacceptable; the road traffic is not obliged to stop before any level crossing or any line. This is a question of principle.

The International Railway Congress cannot impose this obligation in countries where it does not exist.

Mr. Miszke. — We might say : « It is recommended... »

Mr. Tettelin (in French). — It would take more time to cross the level crossing if vehicles had to stop than if they had not to stop. Is it in practice a good thing to start from rest instead of from a speed of 10, 15 or 20 km. making it possible to get over the crossing much quicker ?

Mr. Cancela de Abreu, State Railways in the Portuguese Colonies (in French). — I disagree with the opinion of Mr. Tettelin because it must be pointed out that we are dealing with the unprotected level crossings. Under these conditions it is necessary to make sure before crossing if a train is approaching or not.

I am of course dealing only with the second part of the summary, which has in mind unprotected level crossings with insufficient visibility, and which are not fitted with automatic signals; in such cases vehicles ought to be required to stop.

Mr. Miszke (in French). — There are countries where the level crossings are not protected, or where there are only fixed signals, even if the visibility is insufficient. I think that in such cases the driver of the motor car should stop.

Mr. Tettelin (in French). — I wonder if it is not more dangerous for the driver, because when he starts again it will be from at rest, and he would not have any better visibility and would take longer to cross the line.

Mr. Jourdain (in French). — What is the duty of the driver of a motor car running on to a level crossing ? That of reducing his speed so as to be able to stop if a train is approaching. I think that to go beyond this would involve the responsibility of the railway in cases where it is not concerned.

Mr. Tettelin (in French). — I agree with the proposal of Mr. Jourdain saying that the driver of a motor car arriving at a non-protected level crossing should reduce his speed in such a way as not to cross over if there is any danger.

Mr. G. Ottone, Confederazione Nazionale Fascista dei Trasporti terrestri e della Navigazione interna, Italy (in French). — I suggest that this paragraph be suppressed, because I think it is dangerous to fix limits which can cause greater drawbacks than those it is desired to avoid.

The President. — We have therefore before us two proposals : that of suppressing the summary altogether, and the other of retaining it with or without modification. I will put the question to the vote.

— *The summary was suppressed.*

Mr. Miszke then read summary 16 :

In order to unify the conditions of protection of level crossings, the opinion of the railways should be obtained by submitting to them the regulations proposed for adoption by the future Congress.

Mr. Newlands. — I move the deletion of this summary altogether.

Mr. Miszke (in French). — We have already decided in principle that we must aim at the standardisation of the method of protecting level crossings. To arrive at this it is as well in my opinion to suggest a uniform wording of the regulations and to refer the matter to the programme of the next Sessions of the Congress. If this is not done it will be difficult to arrive at any uniformity in this sense between the different countries.

Yesterday we were told that it was not possible to standardise these things for different countries. We have the same signalling systems in Holland, Egypt, and in England, we have the same system in Brazil, Germany and Poland, and we have great differences on the other hand between the systems used in Germany and Italy, and again between Jugoslavia and Italy, and between Brazil and the Argentine.

Mr. Tettelin. — Who is caused any inconvenience by this difference ?

Mr. Miszke. — The drivers of motor vehicles.

Mr. Tettelin (in French). — It is not essential that there should be the same regulations for erecting signals at level crossings in all countries. All that is necessary for the road users is that these signals should be uniform : and this has been done by the International Convention of the 30 March 1931, which was the result of the work of the European Conference on road traffic held in Geneva from the 16 to the 31 March 1931.

It appears therefore that if the question is referred to the next Congress to be held five years hence, we shall have the same replies as today.

The President. — I think the Permanent Commission suggests the questions to be discussed at the next Congress.

I will therefore put to the vote the proposal of Mr. Newlands suggesting that summary 16 be deleted.

— *The majority was in favour of this summary being deleted.*

Mr. Miszke (in French). — We have still to express an opinion on the second part of Mr. Tettelin's proposal. If the Section is agreed, this text will be inserted between summaries 12 and 13.

— The Section approved this suggestion.

The President. — We have now finished the examination of Question I. This Section will again meet on Monday next to deal with Question II of the Agenda.

— The Meeting was then closed.

DISCUSSION AT THE PLENARY MEETING.

24 January 1933.

PRESIDENT : H. E. IBRAHIM FAHMY KERIM PASHA.
GENERAL SECRETARIES : Messrs. P. GHILAIN, YOUSSEF RISGALLAH BEY,
Dr. I. G. LEVY and FOUAD HASSIB BEY.
ASSISTANT GENERAL SECRETARIES : Sir HENRY FOWLER and Mr. P. WOLF.

The President. — Gentlemen, the object of our meeting today is to examine the summaries of the questions discussed up to now in the different Sections.

The General Secretary, Mr. Ghilain, will read these summaries to you.

Mr. Ghilain, *General Secretary.* — Seeing that we have to deal with eight questions, and for greater convenience, I propose to read these summaries in French only. These summaries as well as the corresponding English and German texts have been published in the three editions of the *Daily Journal of the Session,* so that everyone has been able to make himself conversant with them.

I think that you will all be in agreement on the main points so that there could not be any objections except as regards the wording which could in my opinion be left to the care of the General Secretariat.

Has anyone any objection to proceeding in this way ?

— No objection was raised.

Under these conditions, Gentlemen, I will now read the summaries of Question I, the text of which was published in No. 3 of the *Daily Journal of the Session* on the 23 January.

(**Mr. Ghilain** *read these summaries.*)

The President — Has anyone any observations to make regarding these summaries ?

— As no objection was raised, these summaries were adopted.

Summaries.

« 1. As thanks to the use of motor « vehicles, road traffic, formerly local, « has been transformed into high-speed « traffic and becomes more and more in- « ternational, the Congress invites all « countries to adopt legislation and re- « gulations inspired by uniform prin- « ciples relating to the protection of level « crossings and the types of signals.

« 2. The most effective solution as re- « gards the crossings of the roads with « the railways, the construction of over « and under-passages, can only be carried « out in cases limited to crossings of « roads with very heavy traffic, with « main line railways. This solution « cannot be taken into consideration as « a more or less general rule in view of « the exorbitant cost it would involve.

« 3. In the *United States* the number « of guarded level crossings is diminish- « ing : in 1927 it was only 5 957 out of « a total of 232 000 level crossings. In « certain States the gates are not con- « sidered as satisfactory for fast road

« traffic and they are replaced by *written* « *notices, flashing signs* or by a *keeper* « on the site, who stops the road cars « when a train arrives.

« In *Europe*, on the contrary, there are « methods still in use which relate to « times when the road traffic was quite « different from the present. Efforts « are now made to announce the arrival « of trains at guarded level crossings with « heavy traffic on either railway or road « and in case of insufficient visibil- « ity towards the railway. The suppres- « sion of gates would, however, signify a « progress because the halts on the road « would be reduced to a minimum and « the risk of accidents caused by closed « gates independently of the passage of « trains, would be eliminated.

« 4. In the case of level crossings « where the traffic is of average in- « tensity, it is desirable to consider that « an appropriate signalling gives a de- « gree of protection which is not in- « ferior to that given by the gates and « has this advantages that it interferes « less with the road traffic and prevents « the accidents resulting from collisions « with the gates, so frequently reported.

« If the signalling of level crossings is « required by the law it must be well « understood that the railway adminis- « tration is not responsible for accidents « occurring at level crossings, in the « same way as the road administration « is not responsible for accidents occur- « ring at crossings of public roads.

« 5. Fixed signs in the form of a « St. Andrew's cross preceded, in the « case of roads over which the road mo- « tor circulation is heavy, by an advan- « ced warning sign, should be considered « as sufficient protection so long as the « visibility is good enough.

« 6. In case of insufficient visibility « — taking into account the speed of « trains — fixed signs are good enough « where the number of trains is limitied « and the road traffic is not heavy.

« 7. But if in this case of insufficient « visibility both traffics are heavy, auto- « matic signalling may be recommended.

« 8. The gates should be retained at « crossings with very heavy traffic on « the road and on the railway, when « the automatic signalling is not suffi- « cient, and when keepers and the re- « gulation of the road traffic appear to « be necessary.

« 9. It is recommended to facilitate « the work of the keepers by having the « trains announced to them by the « neighbouring signal boxes if they are « near enough, or by a system of auto- « matic signals.

« 10. To increase the visibility of the « signs and of the gates they should be « painted in stripes of two colours alter- « nately to make them more striking to « the eye and they should also, as far « as possible, be fitted with cat's eye « reflectors.

« 11. In view of the fact, on the one « hand, that the organisation of protec- « tion on the above lines might be very « costly, and the construction of over « and under-passages would be even more « so, and furthermore that the road mo- « tor traffic at high speed does not select « the shortest road, but rather a good « one even if longer, and that conse- « quently the road traffic is concentrated « on a restricted number of level cross- « ings, an endeavour should be made to « reduce as much as possible the number « of road crossings with the railways by « abolishing level crossings with little « traffic, by diverting the traffic towards « those which, having a heavier road « traffic, are fitted with adequate sig- « nalling systems and warning devices « or gates, and by building under and

« over-passages at the places where the « heaviest road traffic is concentrated. « When drawing up schemes for build- « ing and rebuilding the roads, these cir- « cumstances should be taken into ac- « count.

« 12. Following these ideas, and in « accordance with the American practice « (State of New York) the level crossings « can be classified into three groups :

« I. Unguarded level crossings without « gates and without automatic signalling « of the arrival of trains.

« II. Unguarded level crossings without « gates but with automatic signalling of « the arrival of trains.

« III. Guarded level crossings with or « without gates.

« The first category involves the level « crossings where the visibility on the « railway is good and where the num- « ber of trains per day does not exceed « 100 and the product of the number of « trains multiplied by that of the road « vehicles is under 70 000, as well as the « level crossings with insufficient visi- « bility, limited rail traffic and light cir- « culation on the road.

« The second category involves level « crossings where the visibility on the « railway is not sufficient and where the « other conditions are fulfilled.

« The third category involves other « level crossings with heavier traffic. « The most important among these are « generally replaced by over or under- « passages.

« 13. As the increase of the diffi- « culties at level crossings has been caus- « ed by the formerly unknown intensity « of the road traffic, the road should « assume the costs of constructing the « over and under-passages as well as « those for the additional protection of « the crossings required by the growth « of the road traffic. »

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QUESTION II :

The use of mechanical appliances in the permanent way maintenance and in track relaying.

Preliminary documents.

1st report (United States of America, Great Britain, Dominions and Colonies, China and Japan), by Mr. F. M. Thomson. (See *Bulletin*, May 1932, p. 661, or separate issue No. 7.)

2nd report (Latin America, Belgium, Spain, France, Italy, Netherlands, Portugal and their Colonies; Denmark, Finland, Luxemburg, Norway, Sweden and Switzerland), by Messrs. D. Mendizabal and J. Garcia Garin. (See *Bulletin*, August 1932, p. 1567.)

3rd report (other countries), by Mohamed Kamel El Khishin Bey. (See *Bulletin*, June 1932, or separate issue No. 14.)

Special Reporter : Mr. D. Mendizabal. (See *Bulletin*, January 1933, p. 29.)

DISCUSSION BY THE SECTION.

Meeting held on the 23 January 1933.

Mr. D. VICKERS, President of the 1st Section, in the Chair.

The Meeting opens at 9.30 a. m.

The President. — Today we will discuss Question II.

Before we consider the summaries, I will ask Mr. Mendizabal to speak, as he has a few remarks of a general nature to make on his special report.

Mr. Mendizabal, *Special Reporter.* — I would like first of all, Gentlemen, to pay you my respects and express my acknowledgments to the Administrations who, by the valuable data that they have been good enough to supply upon this important question, have enabled me to elaborate the special report for which I was made responsible.

Before reading the summaries that I propose for your consideration and discussion, I would like to call your attention to some of the circumstances characterising the way in which this report has been presented.

All the three reports which I had to sum up, as special reporter, contained

new features of less novelty than those submitted for consideration at the Madrid Congress in May 1930.

It is quite obvious that owing, on the one hand to the short time which has passed since then, and on the other to the world economic conditions, the development of new processes has been hindered.

In addition, the reporters endeavoured to come to definite conclusions — while keeping in mind how much of a relative nature they contained — from data and factors which, as a consequence of the crisis, were often modified, not only through the variations of some importance in wages (in certain countries by increases, and in others by reductions), but also from the fact that the trials of mechanical appliances for use in the maintenance and renewal of the track had not been persevered with; and this because of the difficulties produced by the serious problem of unemployment, from which all countries are suffering.

In view of the need for finding a remedy, practices and opinions previously considered as immutable have received rude shocks, making it necessary even should the situation remain the same, to consider a reduction of the working day, in spite of the extremely serious drawbacks such a measure would cause in the general economical conditions, and in those of the railways in particular.

As a consequence of these facts, the three reporters, and consequently the present résumé will put forth certain criticisable points which really should not be attributed to their authors.

I will now read the summaries :

Summary 1. — Although mechanical methods of maintenance and renewal of the track have been on trial and in use for some years, the results obtained have not been altogether favourable or generally adopted, nor such as could be recommended for definite and immediate adoption. The fact that these trials have not been made on a sufficient scale may perhaps be due to the world economic crisis, as the adoption of such methods would involve the administrations into increased capital expenditure.

In fact there is no great difference between the number of trials made in 1933 and in 1930, and it has not been possible in actual practice to obtain results of a clearly definite and satisfactory nature.

The President. — Has anyone any remarks to make as regards this summary ?

Mr. Tettelin, French Nord Railway (in French). — This paragraph contains an expression which I think goes a little further than the reporter meant, when it says : « the results obtained have not been altogether favourable. »

I think that he has mentally mixed up two things : there have been few results, consequently he has not liked to draw any conclusions. On the other hand the small number of companies who have made tests have obtained results which they consider favourable. Under these conditions it is perhaps going rather too far to say : « the results obtained have not been altogether favourable », and I propose that we say that the number of administrations who have carried out trials of mechanical processes is small and that owing to the short time elapsed it is not possible to draw definite conclusions, although the results are considered favourable by the administrations concerned.

Mr. Herwig, German National Railway Company (in German). — I am of the same opinion as the last speaker. We have

introduced on a large scale mechanical processes for maintenance and renewal of the Reichsbahn track, and have obtained very good results. I consider nonetheless that it is not possible to generalise deliberately the application of our methods to all railways, seeing the great difference between the conditions and especially the working methods in the different countries.

For example, when we renew the track we renew at the same time the rails, the sleepers and the ballast, whereas in America, for example, the rails and the sleepers are not generally renewed at the same time but at different periods according to the wear. It is very difficult to arrive at an economic comparison, which would be agreed by everyone, on these different working methods.

I consider nonetheless that it is useful to exchange the different experience obtained.

Mr. Tettelin. — I am going to submit a proposed wording to replace the two summaries 1 and 2. While I am drawing up the text, the other articles might be examined.

The President. — Is everybody in agreement on the proposal made by Mr. Tettelin ? In order to make the matter quite clear I will ask Mr. Mendizabal to read summary 2.

Mr. Mendizabal. — *Summary 2 :*

Only a very small number of railway administrations have adopted definitely and generally mechanical methods in permanent way maintenance and renewal. The time that has elapsed since the introduction of these methods is too short for the results to be considered as definitive.

Mr. Newlands London Midland & Scottish Railway. — I agree with both these suggestions, but I think it would be an improvement if No. 2 came before No. 1 and I agree with certain other speakers that it is a somewhat sweeping statement to say — as it says in Summary 1 — that nowhere have the results obtained been favourable enough to justify their general adoption. I think this should be, « the results obtained have not been favourable enough to justifiy their adoption in all countries ». That is a simple amendment and is all I suggest. In the last line of Summary 1 it seems to be inferred that new devices should be ruled out because they would involve additional capital expenditure. Such additional expenditure might in many cases be well justified.

Mr. Mendizabal (in French). — I would like to explain briefly why I have worded the summary in the way that it is given in the report.

I am pleased to say that a number of American railways, as well as the German State Railway Co. and the French Nord Railway have carried out very valuable experiments, which have given good results, but although these are very important, these railways do not represent the majority of the railways of the world.

I think that as a description of the results of very important but particular tests, the form of wording I have used will meet the case.

I am nonetheless in agreement that we add to it some mention that some railways have obtained very favourable results without however making it general.

The President. — I take it that we are all agreed that the two summaries should be fused into one. We shall then have to ask Mr. Tettelin to draw up a new text. It will be practically the same — that is, there will be no alteration in the sense of the summary. *(Agreed.)*

We will now pass on to the discussion af Summary 3 which will now become summary 2, while Mr. Tettelin makes a new draft of summaries 1 and 2 together to become summary 1.

Mr. Mendizabal. — We now come to *Summary 3 :*

It may be noted that maintenance work is usually carried out by the Railway Administrations *themselves,* while renewals are done by *contract;* this must not, however, be taken as a general rule.

Mr. Newlands. — I am willing to accept this summary as it stands.

Mr. Herwig (in German). — I suggest that summary 3 be suppressed. Each company should be able to decide if the various works should either be handed over to a contractor or be done by the railway itself. We carry out for example renewal work partly ourselves and partly by contract. Both these methods can be desirable and satisfactory from the financial point of view according to the case.

When renewing the rails and the permanent way equipment we have in many cases organised gangs housed in special trains, who are taken in these trains from job to job. This system has given us very good results.

I suggest we cut out any reference to « contractors ».

The President. — I think this summary is made in a sufficiently general form.

Mr. Herwig (in German). — I would nonetheless like to see my proposal to delete summary 3 carried, seeing that in many countries it might be used by contractors as an argument that all permanent way maintenance work should be handed over to them. It should be left to each railway to decide if one or the other operation or work should be carried out by contract or by itself, the more so as conditions vary considerably from country to country.

In any case the German State Railway Company has proved by its extensive trials that a general discrimination such as that recommended by summary 3 is not desirable.

The President. — I will ask you to vote on the suppression of this summary.

As the votes are 9 for deletion of the summary against 11 for maintaining it, summary 3 is maintained.

We will now take summary 4.

Mr. Mendizabal. — *Summary 4 :*

Among the operations successfully performed by mechanical appliances, we may note the following :

a) Transport of staff and material by trolleys;
b) Transport of ballast in special wagons;
c) Screwing screw spikes;
d) Tamping sleepers;
e) Screwing fishbolt nuts;
f) Sifting and grading ballast;
g) Adzing and boring sleepers;
h) Weeding;

According to the reports these are the principal processes that have given absolutely favourable results.

Trials have been made of carrying out other operations mechanically, which are too narrow in scope to be given in the general list of the works mentioned in the summary.

Mr. Herwig (in German). — There is an operation in which we also use mechanical processes, not mentioned in summary 4 : the transport and laying of complete sections of track by means of special wagons used in renewing the track.

The German National State Railway Company has had very good results from this process; I should therefore like the words « the mechanical renewal of the track by means of crane-wagons » to be added.

Mr. Mendizabal (in French). — I do not see any objection but in fact this is a trial carried out almost solely by the German State Railway Company; for this reason I did not mention it in article 4, however I am not opposed to it being mentioned in the summary.

Mr. Herwig (in German). — Not only in Germany but also, as far as I know, in France and America this method is used.

Mr. Hossu, Rumanian Railways (in German). — We could also mention in summary 4 machines for cutting and drilling rails; these save considerable time and give good results.

Mr. Mendizabal (in French). — I have only mentioned in summary 4 the operations carried out mechanically by the majority of railways. I am aware that many others can be done in the same way, but I have limited myself to those carried out almost generally on the different railways.

Mr. Hossu (in German). — Under these conditions, I am in agreement with the special reporter.

Mr. Tettelin (in French). — I think that we should take notice of Mr. Herwig's proposal, because it is a question of an operation which cannot be done without mechanical appliances, and it would be a pity not to mention it when dealing with mechanical equipment.

I recognise that this operation is not generally carried out in this way, but I think nonetheless that the Special Reporter might make an exception to the rule that he has laid down and add : « Taking up, carrying away and laying totally assembled track .»

Mr. Schutz, *Section Secretary*. — Where would you add this ?

Mr. Tettelin. — At the end.

Mr. Mendizabal. — I agree.

Mr. Driessen, Netherlands Railways (in French). — Mr. President, I do not wish to oppose the proposed addition, but I would like to contradict Mr. Tettelin when he says that it is not possible to replace the track without mechanical equipment. We do this in Holland without any mechanical plant, and I can say that we do it very cheaply and certainly at no higher cost than when mechanical methods are used.

Mr. Tettelin (in French). — I did not say that it is not possible to replace the track without mechanical equipment, but that it is not possible to remove a complete section of track and replace it by another without mechanical appliances. That was what I meant.

The President. — I will now ask you to vote on the adoption of summary 4 with the addition proposed by Messrs. Herwig and Tettelin with regard to the mechanical renewal of the track.

Mr. Newlands. — I think the resolution is a good one but it is not complete unless it includes the building up of crossings in the track by electric welding and mechanical lubrication of rails on curves.

Mr. Mendizabal (in French). — I agree with Mr. Newlands, however, I think that this operation is not sufficiently important for it to be mentioned in the summary.

Mr. Newlands. — I do not agree. I consider that electric welding of crossings and lubrication of rails are the coming features of railway maintenance.

Mr. Herwig (in German). — I still consider that the addition I proposed should be made; do we not in fact say : « Among the operations successfully performed by mechanical appliances ...» without specifying if these works are general ?

For taking up, carrying away, and laying down totally assembled sections of track, the German State Railway Company has obtained extremely good results; it has been able to do this work economically, and the work has been well done from the technical point of view.

Mr. Tettelin (in French). — We have had the same results.

The President. — We have therefore two proposals :

That of Mr. Herwig which consists of adding : « *i*) taking up, carrying away, and laying down totally assembled track. » *(Unanimously adopted.)*

And that of Mr. Newlands who also wishes to mention electric welding in track work and the mechanical lubrication of rails on curves.

Dr. Tanaka (Japanese Government Railways). — I am of the same opinion as Mr. Newlands, that electric welding of crossings and mechanical lubrication is most satisfactory.

Mr. Newlands. — I submit that there is nothing that comes better under the heading of mechanical maintenance than the two appliances I have mentioned.

The President. — I am now going to put to the Meeting the question of adding Mr. Newlands' suggestion of electric welding for repairing the line and mechanical lubrication of the inner rails on curves.

— The proposal is rejected and summary 4 becomes summary 3 with the addition *i*) previously voted above: « Taking up, carriyng away, and laying down totally assembled track. »

Mr. Mendizabal. — We now come to summary 5 :

Very few of the administrations have supplied any information on the economic side of the question; it is therefore impossible to establish concrete conclusions by comparing the net costs of the mechanical and manual methods. It is to be hoped that in the future the administrations making such trials will continue to furnish details and make comparisons in order to enable this problem to be solved.

I noticed in the reports considered complete absence of information of an economical nature, except in the case of some few administrations who have supplied data of this type. This is a pity, because in reality the main reason why the railway companies have been led to adopt mechanical processes for the maintenance and renewal of the track is of an economical nature, although at the same time reasons of a technical nature are taken into account, to see the work is being properly done.

As I have shown in this summary, I hope that in the future the administrations who carry out tests by mechanical

processes will be willing to supply information of an economic nature, with diagrams and statistics, so that we can really arrive at a comparison between the mechanical and manual systems.

Mr. Herwig (in German). — I would like to remark that the German State Railway Company had already supplied, on the occasion of the Madrid Congress, information on the subject of the savings obtained by the use of mechanical processes for the maintenance and renewal of the track. It is still carrying out investigations into this economic question.

It would, moreover, be difficult and not absolutely essential to get out for the total work done in a different way, as regards the different partial operations and under local conditions, an economic evaluation of general application and uniformly comparable.

I think nonetheless that it is quite possible and important to determine, for the different partial operations involved in the whole job, for example when renewing the track, for picking up the track, carrying away the track, renewing the sleepers, etc., the savings it is possible to obtain by using mechanical methods and to show that the results we get are comparable with those of other railways.

The figures obtained by the German State Railway Company for certain complete renewals ought not, as has been already said, to be compared with those of other countries, seeing that in our country the work is carried out in a different way and by the aid of other appliances than those used on the French and English railways.

It is nonetheless valuable and instructive to compare the savings obtained by this work.

I agree that summary 5 should be maintained, but I would like to see my remarks on the savings effected and the comparison of these savings retained in the minutes of our discussions.

Mr. Driessen (in French). — Mr. President, as reporter on this question for the Madrid Congress, I quite understand that it is very difficult to compare the information of an economic nature supplied by the different railways, seeing that as a rule we do not know how the figures of expenditure have been arrived at, whether proper account has been taking of the amortisation fund, of the interest on the purchase price of the machines, etc., in a word we are very badly informed as to the economic side of the question.

I should also like to remark that this summary is quite negative, whereas summary 6 does put forward something positive as regards the same principle.

I think therefore that we would not lose anything if we dropped summary 5 and retained summary 6.

The President. — In summary 5, we have added however : « It is to be hoped that in the future... »

Mr. Driessen (in French). — In my opinion this could be added to summary 6, and the whole beginning of summary 5 suppressed.

Mr. Torres Quevedo y Polanco, Ministry of the Fomento (Spain). — I also consider that summary 5 is not absolutely negative, because it expresses a most important wish.

Mr. Schutz. — This is just what Mr. Driessen asks: suppress the first part, but keep the second and add it to summary 6.

Mr. Torres Quevedo y Polanco (in French). — I quite agree; it would prob-

ably be as well to add to the summary : « It is to be hoped that the administrations will continue to keep detailed records with all the indications lacking » as was pointed out at the Madrid Congress.

The President. — Mr. Driessen, do you agree to retain the second part of clause 5 and add it to the end of clause 6 ? As regards Mr. Torres' proposal to mention other points, I think that this would make the summary too heavy, but that it might be mentioned in the proceedings.

Mr. Driessen. — I am quite in agreement.

Mr. Mendizabal (in French). — I think it would be as well if we continued to supply information of an economic nature because, if it is found that mechanical operations enable savings to be made in Holland, France, America, etc., although the savings obtained in these countries may be different, it is reasonable to conclude that the system is an economical one.

With this object, I think it is valuable and important that information be given in a statistical form.

If, however, my colleagues think it desirable, I should not object to the first part of summary 5 being suppressed, although it forms in reality the justification for the second and more important part.

Mr. Duchateau, *Principal secretary* (in French). — Under these conditions, is everyone in agreement to adopt the wording of the second part only of this summary, the first part being suppressed ?

— Summary 5 is adopted, but only the second paragraph, as follows : « It is to be hoped that... »

Mr. Duchateau. — Are we in agreement that summaries 5 and 6 be joined and that the second paragraph of summary 5 be put at the end of summary 6 ?

(This proposal was approved.)

Mr. Mendizabal (in French). — Summary 6 is as follows :

It should be noted that the only administrations who have supplied information on the economic side of the question with any degree of completeness are the North American Railways. The high cost of labour in the United States is a particular circumstance which makes it difficult to compare the cost with the corresponding figures for other countries, especially of Europe. Consequently the results obtained cannot be applied to other countries, European or others, as if they were the fruit of more extended trials, because the same set of circumstances does not exist in the various countries.

The President. — Does anyone wish to raise any objection to summary 6 ?

Mr. Gatford (East Indian Railway). — There is a suggestion I should like to make in connection with obtaining details from other countries. I wish to state that it should be made more definite what detailed information is required, especially with regard to figures and that the particulars needed be specified, possibly in an appendix. In my opinion, this would have three advantages. It would make sure that the figures we receive are relevant; it would facilitate comparison with the figures already obtained; and it would act as an inducement to administrations to obtain these figures.

The President. — It was settled that the last half of summary 5 should be added to the end of summary 6. Does that accord with your ideas ? Would you

like to supplement the last part of summary 5 with a few words ?

Mr. Gatford. — The summary might be amended to read : « It is requested that Administrations will continue to furnish details on the points specified in the Appendix. »

The use of mechanical appliances will come last where manual labour is cheapest, and until such time as we get details from India and similar countries, where manual labour is relatively cheap, it will not be possible to obtain complete justification for the use of mechanical appliances in all countries, which the increasing cost of labour generally, together with the economic position of railways, demands as advisable.

Mr. Newlands. — We English have the feeling that summaries 5, 6 and 7 are not properly conclusions at all — they are more in the nature of comments on the subject matter of the proposals and we are of the opinion that the whole of summaries 5, 6 and 7 should be dealt with at the same time and the second half of summary 5 (which it is suggested be retained) should form the closing sentence of summary 8, and accordingly we would eliminate 5 and 7 entirely and in No. 7, where the words « political considerations » arise, we are of opinion that such considerations do not come within the province of this meeting at all, so that we feel summaries 5, 6 and 7 should be deleted entirely except that the second half of summary 5 should be the closing sentence of summary 8.

The President. — I should like to know Mr. Mendizabal's opinion ?

Mr. Mendizabal (in French). — We have already approved the second part of summary 5. I have also read out summary 6. What exactly is now proposed ?

The President. — Mr. Newlands considers that summaries 6 and 7 should be suppressed, and that the second part of summary 5 should be added to summary 8.

Mr. Mendizabal. — I willingly accept the opinion of the Meeting.

Mr. Newlands. — I think articles 6 and 7 are more comments than definite conclusions.

Mr. Driessen. — I agree with Mr. Newlands.

The President. — I will therefore now ask you to vote on the suppression of summary 6.

— This was carried unanimously.

I now put summary 7 before you; the text is as follows :

It must not be forgotten that these investigations have been made during a period when the whole world finds its economic structure upset; the result is a wide variation in prices and conditions of life in each country. It is therefore difficult to compare the results, the more so if we take into account the fact that the attitude and conduct of certain countries has been heavily influenced by political considerations which have prevented the railways from dismissing large numbers of workmen, which would have aggravated still more the problem of unemployement. In some cases official pressure has even obliged them to increase the number of their workmen.

— This was also unanimously suppressed.

Now let us take summary 8 with the second part of summary 5 beginning with the words : « It is to be hoped that... »

Mr. Mendizabal. — Summary 8 :

In view of all this, this interesting investigation should not be considered as completed. The subject of this question should therefore be kept before future Congresses, acknowledging at the same time that much new information has become available since 1930.

The President. — I should like to know if it is desired that the second part of summary 5 be put at the beginning or the end of summary 8 ?

Mr. Driessen. — We might leave the Office to decide how this should be worded.

The President. — This being so, I now ask the opinion of the Meeting on summary 8.

— This summary was adopted.

We now have to reconsider the text of summaries 1 and 2, the new wording of which has now been put before us.

Mr. Duchateau (in French). — The text proposed by Mr. Tettelin in agreement with Mr. Mendizabal is as follows :

« 1. Although mechanical methods of maintenance and renewal of the track have been on trial and in use for some years, only a limited number of Railway Administrations have adopted them definitely and generally.

« The time that has elapsed since the introduction of these methods is very short and no definite conclusion can be drawn from the results obtained, although the Administrations using them have found them convenient.

« The small number of trials may be attributed to circumstances arising from the world economic crisis. »

The President. — Do you agree to adopt this new wording drawn up by Messrs. Tettelin and Driessen, and approved by Mr. Mendizabal ?

— *Unanimously adopted.*

Mr. Tettelin. — Mr. President, now that all the summaries have been considered, I would like to point out that in Mr. Mendizabal's report the shovel packing method replacing tamping in permanent way maintenance has been pointed out.

This has not been mentioned during our discussions, but I think it well to draw the attention of the Section to this method which consists in introducing under the sleepers a small quantity of small stones, instead of tamping with the pick.

I noticed the use of this method in England 30 years ago, on the former London & North Western Railway, and I have introduced it on the French Nord Railway; the chief ganger decides, after inspecting the track, how much chipped stone is required under the sleeper to block it. This is not easy because, when the track is under load, it is pressed down more than when there is no load on the sleepers, and the sleepers are inspected when there is no load on them.

The result was nonetheless fairly satisfactory. To improve it, one of our engineers, Mr. Lemaire, has invented a small instrument to measure under loads the quantity required to block the sleeper in order that there should be no movement in the track. This method is known as « measured packing ».

I have brought to Cairo a film which shows how the work is done. This film will be shown on Wednesday.

Mr. Newlands. — I am very interested. What Mr. Tettelin is referring to is the

principle adopted on the London North Western of levelling up by the use of small chips, instead of heavy ballast. The sleepers are raised slightly and the chips laid under and the sleeper is then laid down again and that has been the practice on the London & North Western for many years and is being copied by other railways, and I am very glad to tell Mr. Tettelin that we have a sample of the device he refers to in use on the London, Midland & Scottish Railway to-day. We heard of it, liked it and have it in use on our system and from what we have seen it is likely to be of permanent standing. It indicates the amount of give in every sleeper as the train passes over it, so that we know when building up is required and the exact amount of filling is measured out in a special device.

Dr. Tanaka. — In Japan we have found it very advantageous to fasten the ends of wooden sleepers with wire, because in our country the climate in winter is very dry, which causes the wood to split at the ends. We have devised special tools for fastening the wire on the sleepers very economically. We are using this method all over Japan and I am very anxious that it should be used in all countries, as it is a great improvement on other methods. This suggestion might be put to the next Congress if it proves successful in other countries.

The President. — We have now dealt with the whole of Question II. Has anyone any further proposal to put before us ?

— As nobody wished to speak, the Meeting terminated.

DISCUSSION AT THE PLENARY MEETING

held on the 24 January (morning).

H. E. Ibrahim FAHMY KERIM Pasha in the Chair.

General Secretaries : Messrs. P. GHILAIN, Youssef RISGALLAH Bey, Dr. I. G. LEVI and FOUAD HASSIB Bey.

Assistant General Secretaries : Sir Henry FOWLER and Mr. P. WOLF.

Mr. Ghilain, General *Secretary*. — We will now take Question II of Section I. The text of the summary has been published in the *Daily Journal* of the 24 January.

— *These summaries were then read.*

The President. — Has anyone any remarks to make about this text ?

— As no one has any remarks to make, these summaries will be considered as adopted.

Summaries.

« 1. Although mechanical methods of « maintenance and renewal of the track « have been on trial and in use for some « years, only a limited number of Rail- « way Administrations have adopted « them definitely and generally.

« The time that has elapsed since the « introduction of these methods is very « short and no definite conclusion can be « drawn from the results obtained, al- « though the Administrations using « them have found them convenient.

« The small number of trials may be « attributed to circumstances arising « from the world economic crisis.

« 2. It may be noted that maintenance « work is usually carried out by the « Railway Administrations *themselves*, « while renewals are done by *contract*; « this must, not, however, be taken as a « general rule.

« 3. Among the operations successfully « performed by mechanical appliances « the following may be noted :

« *a*) Transport of staff and material « by trolleys;

« *b*) Transport of ballast in special « wagons;

« *c*) Screwing screw spikes;

« *d*) Tamping sleepers;

« *e*) Screwing fishbolt nuts;

« *f*) Sifting and grading ballast;

« *g*) Adzing and boring sleepers;

« *h*) Weeding;

« *i*) Taking off, carrying away, and « laying totally assembled track.

« 4. In view of all this, this interesting « investigation should not be considered « as completed. The subject of this « question should therefore be kept be- « fore future congresses, acknowledging « at the same time that much new in- « formation has become available since « 1930.

« It is hoped that the Administrations « carrying out trials will continue to « keep detailed records in order to fur- « ther the solution of the problem of « the comparison of cost between me- « chanical appliances and hand labour. »

[621 .135. (01, 625 .14 (01 & 625 .22]

QUESTION III.

The relationship between the vehicle and the track, to ensure safety at high speeds.

A) *Weight of vehicles per axle, position of the centre of gravity, wheel arrangement, layout to facilitate running through curves;*

B) *Track resistance, widening of gauge, radius of curves, superelevation, transition curves, points and crossings, check rails.*

Preliminary documents.

1st report (America, Great Britain, Dominions and Colonies, China and Japan), by Messrs. S. Matsunawa, S. Kurokochi and K. Asakura. (See *Bulletin*, June 1932, p. 1045, or separate issue No. 16.)

2nd report (all countries excépt America, Great Britain, Dominions and Colonies, China, Japan, Germany, Denmark, Finland, Norway, Spain, Netherlands, Portugal and their Colonies, Sweden and Switzerland), by Mr. Hynek Deyl. (See *Bulletin*, November 1932, p. 2141, or separate issue No. 36.)

3rd report (Germany, Denmark, Finland, Norway, Spain, Netherlands, Portugal and their Colonies, Sweden and Switzerland), by Messrs. H. Baumann and F. Jaehn. (See *Bulletin*, December 1932, p. 2251, or separate issue No. 37.)

Special Reporters : Messrs. R. Despret and A. W. Chantrell. (See *Bulletin*, January 1933, p. 34.)

SECTIONAL DISCUSSION.

Meeting held on the 26 January 1933 (morning). (1st and 2nd Sections meeting jointly.)

Mr. D. VICKERS, President of the 1st Section, in the Chair.

The Meeting opens at 9.30 a. m.

The President. — The special report on this question is divided into two parts: the first, *The Vehicle* — the second *The Track*. Each of these main parts is divided into a number of smaller parts in the clearest possible way.

I begin by asking Mr. Chantrell, Special Reporter on the first part — *The Vehicle* — to introduce his report to us in

a few words and to add to it, if necessary, what he thinks he ought to tell us, and I shall then ask Mr. Baumann and the other Reporters if they agree with the report of Mr. Chantrell, of if they wish to add anything to it, and then we will take the discussion of Mr. Chantrell's chief summary.

The method evolved by Mr. Chantrell will make the procedure of the discussion very much easier. I will now call upon Mr. Chantrell to present his report to us.

Mr. Chantrell, *Special Reporter* (in French). — The question of the relationship between the vehicle and the track, to ensure safety at high speed, was the subject of three reports : that of Messrs. Matsunawa, Kurokochi and Asakura; that of Mr. Deyl, and that of Messrs. Baumann and Jaehn.

Each of these reports consisted of two parts : the first specially devoted to the *vehicle*, the second to the *track*.

We have therefore first of all to consider the part devoted to the *Vehicle*.

Each of the three reports contains a very complete description of all the elements of the vehicle affecting the question of safety at high speed, for steam and electric locomotives, as for tenders and carriages.

The whole of this data forms a very valuable documentation, the elements of which have been collected by the various reporters in a most conscientious and methodical manner.

As regards the question of adapting the running gear to irregular surfaces of superelevation inclines, we would like to call particular attention to the very valuable contribution of Mr. Baumann.

He has studied the problem of the influence of the method of suspension on the pressure of the guiding wheels running onto the transition gradient when leaving a superelevated curve. Each method of suspension has been defined by a characteristic coefficient of support, which represents, we might say, « the statical quality » of the springing.

Mr. Baumann has reported the recent investigations of the German Railways as regards conditions of safety against derailment.

These investigations have made it possible to prepare a new formula, giving the ratio between the transverse reaction of the rail and the vertical load on the wheel, in terms not only of the coefficient of friction and the angle of inclination of the face of the wheel flange, as in the classical formula, but also of the diameter of the wheel and the elements defining the striking angle.

Finally, the various Reporters call attention to the investigations and tests which have been carried out concerning the dynamic actions due to the shock produced by the sudden oblique contact of the guiding wheels, and as regards the determination of the loads on the wheels and the guiding forces actually taking place in the case of a running vehicle.

The consideration of these various reports has led to the observations and summaries which I have given in the special report.

The President. — Does Mr. Baumann wish to make any remarks on Mr. Chantrell's report ?

Mr. Baumann, *Reporter* (in German). — I would first of all like to tell Mr. Chantrell how much I appreciate the fact that in spite of the little time he had for the purpose, he has so well succeeded in summing up this difficult question in his special report. I will add that the whole of this question ultimately resolves itself into knowing how the guiding force

should be proportioned to the vertical load on the guiding wheel so that we may be sure that the vehicle will not come off the track.

As the guiding wheels do not lift so long as they carry sufficient load, it is very important to understand what has to be done from the purely statical point of view to maintain the necessary wheel pressure. It is therefore a question of showing in an exact way the statical forces with the method of construction of the bogies and the system of support of the vehicle adopted. This is what I explained in my report, showing at the same time to what extent the springing influences the value of the layout adopted.

As regards the last page of the 3rd summary on page 35 of the English text of the special report : « The notion of the guided length and consequently of its relation to the rigid wheelbase is thus not so clearly defined as in the case of steam locomotives », I would like to remark that electric locomotives, like steam locomotives, have to have a guided length. In my opinion we should, therefore, not say that in the case of electric locomotives the guided length and the ratio of this length to the rigid wheelbase has not the same importance as in the case of steam locomotives. A guided length ought therefore to be arranged on electric locomotives; it is provided on the $1D_01$ locomotives fitted with Krauss-Helmholtz bogies mentioned by the Special Reporter. The strong centring springs of these bogies indirectly guide these locomotives. Otherwise these locomotives would not run over the line with safety.

The President. — We will take in turn the various paragraphs of the special report.

Has anyone anything to say about paragraph 1 ? *(Nobody wished to speak.)*

The President. — As nobody wishes to speak on paragraph 1, we will now take paragraph 2 relating to the *rigid wheelbase* and the *guided length* of the locomotives.

Mr. Chantrell, do you wish to add anything ?

Mr. Chantrell. — Mr. Baumann has made on this subject a remark which makes the question quite clear.

The President. — We will now take the 3rd paragraph of the special report, dealing with *wheel loads*, an then return to the summaries. We are dealing with the text of pages 35/36 of the special report : « Generally speaking, the *loads* on the driving or coupled axles of a steam or an electric locomotive are the same. »

Mr. Chantrell, would you like to add anything to this text ?

Mr. Chantrell (in French). — We are dealing here with remarks of a general nature on the distribution of the loads; these vary considerably, and it would be very difficult to draw up a clearly defined summary.

The President. — Does anybody wish to speak on this subject ?

(Nobody wished to speak.)

We will now take the 4th paragraph, page 36 :

« A high centre of gravity of the locomotive... »

Does anybody wish to speak on this questions ?

(No objections were raised.)

We will now take the following paragraph, page 36 :

« *Steam locomotives* have 3, 4, 5 or 6 points of suspension, these being in 2 or

3 supporting planes. Three-point suspension is relatively frequently used. »

Mr. Chantrell (in French). — This paragraph sums up the information provided by the reports as regards the methods of suspension, the lateral play of the bogie, the transverse play of the wheels and axles, and finally the thinning of the wheel flanges.

The President. — Has anybody any remark to make on these different matters ?

As nobody wishes to speak, we will now take the following paragraph, page 37 : « The controlling gear fitted on steam locomotive bogies... »

Do we agree with this wording ?

Mr. Wood (Sudan Railways). — I notice a very great difference between the initial centring force exerted by the bogie controlling systems in certain administrations. In some administrations it is as little as 2 tons; in others it is as great as 8 tons. As I believe this question of controlling action is largely bound up with the question of tyre wear, I shall be very glad to know if the very high controlling force is more satisfactory and if it has been successful in reducing tyre wear ?

Mr. Baumann (in German). — Mr. Wood has pointed out that the initial loads of the centring devices are calculated in a very different way by certain railway administrations, and that the value of the centring force plays a part in the wear of the flanges. He wishes to know what is the value giving the most satisfactory results. I may perhaps answer as follows to his question which only considers the economic side of the guiding action.

Each locomotive requires a certain directing force for guiding. If on a curve, there is a transverse movement of the bogie centre line relatively to the longitudinal centre line of the locomotive, the orientation of the main frame, i. e. the continued deviation of the wheels following the bogie, requires a transverse force running from the bogie to be exerted on the pivot displaced with the main frame towards the left or right, or in other terms on the longitudinal centre line of the locomotive. To this effort, that we call the guiding effort of the pivot, is opposed the effort represented by the reaction of the side face of the rail. This opposing force guides the guiding wheel of the leading bogie, the flange of which comes into contact with the side of the rail; it props itself, as it were, against the rail with a pressure that we designate under the name of guiding pressure Y, and which must necessarily be greater than the guiding force of the bogie centre pin, since the bogie, considered separately, also requires a transverse force to guide it. That briefly is what happens.

Now the builder is responsible for seeing that the guiding pressure Y is not too great. It is a question therefore of being prudent, as the smaller Y remains, the more the ratio of the value of the guiding pressure Y to the wheel load Q will be favourable. The examination of the new types of bogies has shown that great prudence is displayed when calculating the centring forces, especially in the case of high-speed locomotives.

On this subject, I would refer to my remarks on the Winterthur type bogie, developed in our German report. I have shown everything that has been attempted to make sure that the centring force only increases very gradually as the movement of the pivot increases.

Sir Henry Fowler (London, Midland & Scottish Railway). — In reply to Mr. Wood's question I should like to say that I think this is a very important point. On the London, Midland & Scottish Railway we have carried out some very extensive experiments which unfortunately are not yet finished, but they point to the fact that this is a thing which should be very carefully watched, particularly from a wear point of view. In the case of a 4-6-0 locomotive, the wear which takes place on the leading coupled wheels is very important.

The President. — We will now take the following paragraph, page 37 of the English text of the special report : « *As regards the adaptation of running gear to irregular surfaces of superelevation inclines.* »

Mr. Chantrell (in French). — This paragraph deals more especially with Mr. Baumann's investigation into the problem of the ratio between the variations of pressure on the guiding wheels and the method of suspension of the locomotives and bogies.

The paragraph gives a short review of the results of this investigation, the conclusions of which can be summed up as follows : in order to guarantee a sufficient static pressure on the guiding wheels running on to a transition gradient on leaving a curve, it is recommended that the method of suspension of locomotives on two transverse planes, i. e. at three or four points, be used.

If the 3-point support is necessary, it is desirable to give the preference to the method of central support on the bogie by a spherical pivot.

Mr. Baumann (in German). — This paragraph shows that the quality of the support can be expressed precisely by the characteristic « C » of the bogie.

Mr. Schutz, *Section Secretary* (in German). — The whole of these paragraphs or a part thereof are based on this investigation of Mr. Baumann's report so far as it is solely a question of the statical side of the problem. The principal question is this : What is to be understood by the « characteristic of the bogie », the idea on which this investigation is based?

Mr. Baumann (in German). — The change ΔP in kgr. that the pressure P of the guiding wheel of the bogie undergoes when it is elevated or lowered by X mm. is (page 2296 of our report) :

$$\Delta P = C \delta X$$

in which C is the « characteristic of the bogie » and δ the stiffness of the springs in the frame, in kgr. per mm.

The values of C are shown in figures 19 and 22, pages 2298 and 2302 of our report, for the support in three planes (values C_3) and in 2 planes (values C_2) as ordinates above the values of the abscissæ $f : s$, in which f is the transverse distance apart of the carrying springs, s the transverse distance apart of the points of support of the wheels on the rails. The symbols *Ce*, *Cs*, *Cme*, *Cms*, etc., relate to the different types of bogies ; they are explained in our report, page 2274. The figures make possible, therefore, a numerical comparison of the static value of the different types of bogies, with support in two or three planes, but this, as I purposely pointed out, does not take into account the friction of the springs.

The mathematical deduction of the values C in a general form is not given in my report. This would have taken up too much space. I give it elsewhere. However the faculty of being able to show the

static value of a type of bogie in an exact way and of using it for a comparison with other types is so valuable that I thought it desirable to place this method before the Congress. It is the result of our investigations and for the first time it has been brought to the knowledge of wider circles by our report on Question III.

In order to ensure that the pressure of the bogie wheels is maintained, it is not a matter of indifference whether we select such and such a stiffness for the springs of the main frame, and such and such a stiffness for the bogie suspension springs. It is true that the rolling stock builder knows that it is necessary to use flexible springs on the bogies; but undoubtedly no one knew the relations which exist between the variations of pressure exerted by the wheels when running over track irregularities, according to the stiffness adopted for the bearing springs of the main frame and of the bogie. These relations are also brought out by our bogie characteristic C. For this purpose the values of C have been calculated for the *proportional* spring stiffnesses p; they are inscribed on the diagrams, figures 19 and 22. The value p expresses therefore the ratio of the stiffness of the springs of the main frame to the stiffness of the bogie springs. Thus for example, a curve C for $p = 1.1$ represents a bogie, the springs of which are less stiff than those of the main frame. In the case of curve C with $p = 0.7$, the contrary is the case.

In the third part of my report, I have endeavoured to make it clear to what extent the more or less considerable change of pressure exerted by the guiding wheel depends upon the method of construction of the bogie. It is desirable that the variations of wheels pressure should be as little as possible, as a guiding wheel will never come off the rail if it is always carrying sufficient load. In the same way a guiding wheel will not derail if the transverse force with which it bears against the side of the rail is relatively small.

The diagrams which you have in the special reports show, therefore, to what extent more or less a given type of bogie assures the static pressure of the wheel being maintained.

Another point requires attention. In the replies we received, bogies were mentioned, with a flat central disc 620 mm. (2 ft. 3/8 in.) in diameter on which the main frame is carried. All bogies of this type will necessarily come off the rails on superelevation inclines, at least on down gradients, if they are fitted with laminated bearing springs only. The administration which uses these bogies has, however, wisely provided double suspension gear, with laminated springs and helical springs. The springs are mounted in series. In this way a very marked reduction in the stiffness of the springs is obtained. In the case considered the stiffness of the laminated springs had the high value of 250 kgr./mm. (28 000 lb. per inch) and that of the coiled springs 50 kgr./mm. (5 600 lb. per inch). The resulting total stiffness has been brought down to $\frac{250 \times 50}{250+50} = 42$ kgr./mm. (2 352 lb. per inch). In cases of differences in level or sudden alterations of height, a spring gear as flexible as this is very good; I consider it more rational than the use of transverse compensating levers at the leading end, because the changes of height have to be taken up in fractions of a second, and the transverse compensating levers on account of their inertia and frictional resistances do not follow

the movement as quickly as the coiled springs.

The type of bogie described above nonetheless shows how important the arrangement of the springs selected as regards the adaptibility of this bogie, in spite of its 620-mm. (2 ft. 3/8 in.) diameter disc bearing, has been.

I have spoken at considerable length on the subject of the spring gear, because of its extreme importance for safety in guiding, and because, when discussing the summaries, we shall again have to consider the solution to be used in future.

The President. — We will now take the paragraph on page 38 dealing with the *guiding of the locomotive :* « The general opinion is that the guiding of the locomotive... »

Has anyone any remark to make on this subject ? *(No remark was made.)*

We will now take the following point : « Security against derailment... »

Mr. Chantrell (in French). — I have drawn special attention in this paragraph to the fact that so far the condition of security against derailment was expressed by the classical formula of Marié, giving the ratio between the transverse reaction Y of the rail on the flange and the vertical load Q of the wheel in terms of the coefficient of friction μ of the rail on the wheel, and of the angle of inclination α of the face of the flange on the horizontal.

The investigations of the German *Verein* have made it possible to establish another formula which is more accurate and which expresses the condition of safety against derailment in terms of the striking angle or rather in terms of the elements which define the striking angle.

As a corollary to these remarks, it is also desirable to call attention to the question of flange lubrication. Tests are being made by most railways, and I have mentioned among others the case of the Japanese State Railways which have adopted the method of continuous watering of the rail with water from the tender.

This system, according to the Japanese reporters, has given very satisfactory results.

The President. — Has anyone any remark to make on this question ?

Mr. Newlands. — I think, Sir, that from the point of view of all those responsible for the safety of railways this is one of the most interesting summaries we have been considering. The report points out that the ratio between the transverse reaction of the rail on the flange and the vertical load on the wheel has hitherto been considered as a predominent factor. I think we have all gone on that assumption. What the Reporter says is perfectly true and he is endeavouring to improve by still further investigations the value of this formula accepted in the past. This formula quite obviously has reference to theoretical principles — theoretical rather than practical. For instance, it assumes that, under certain running conditions and speeds, the weight on the axle shall be that for which the engine was originally built. The question as to how far those weights, when running, lurching and heaving at high speed round curves, will apply, is obviously one which is almost impossible of determination, and those of us who are at times worried about this question are sometimes driven to the conclusion that something other than theoretical deductions may have a bearing on the whole question. I refer to possible — I do not say actual — but I do refer to possible

disturbances or circumstances which are incapable of theoretical deduction. For instance, if you can imagine a heavy engine running at high speed with a heavy train behind it being suddenly called upon to put on the brake for some reason or other, what happens in these circumstances is that the heavy engine comes first of all under the influence of the brake application and the effect of that application is somewhat retarded as it travels down the train to the rear vehicle. The fact therefore that this heavy engine is subjected to impact from the coaches behind it until such times as the rear vehicle comes under the influence of the brake has been brought to rest has the effect that this heavy engine becomes a rigid mass, but at the same time, although it is brought under the influence of the brake, it is still subjected to the battering ram effect of the train behind it, until it also has been brought to rest, and I sometimes think that while this engine in its state of rigidity is being buffered into by the following train, it is not within its capacity to adapt itself to normal running in the way it would, were it not subjected to the instant brake application and the successive blows of the coaches behind it.

I should like to ask if Delegates have seen the possibility of derailment from this cause, that is to say, the possibility of a heavy goods or passenger train being derailed on a curve under the circumstances I have outlined.

Mr. Tefvik Fazli, Turkish State Railways (in German). — A few months ago an accident of this type occurred in Turkey. A heavy goods train was descending a gradient of 1 in 83 and at the precise moment that it arrived on the level section, the engine having cleared the curve, the derailment occurred. The driver had applied the brake heavily and the wagons had bunched up. The train of 30 to 40 wagons weighed 650 tons; it derailed on leaving the curve, and not when running onto it. The accident was a serious one, and 10 wagons were seriously damaged.

The President. — As nobody wishes to speak on the subject of the paragraph in question, we will now take the last paragraphs, page 39.

Has anyone any remarks to make ? *(No one wished to speak.)*

We have now finished the general examination of the special report as regards the part : *The Vehicle*, and now we can take the summaries relating to this part.

Mr. Chantrell. — Thet text of *Summary 1* reads :

> For high-speed steam locomotives, guiding by four-wheeled carrying bogies is found to be the general practice. Two-wheeled trucks are more rarely used.
>
> High-speed electric locomotives have four-wheeled carrying bogies, or bogies with 2 carrying wheels and two driving wheels, or two-wheeled trucks, or a bogie for one direction of running and a two-wheeled truck for the other, or again two driving bogies.
>
> It is recommended that the vehicle should be guided by the bogie centre pin only, that a long rigid wheel base be provided with as long a guided length as possible.

The President. — Has anyone any remarks to make ?

Mr. Baumann (in German). — The tests carried out by the German State Railway Company, mentioned several times in our report, have shown beyond question that tenders with four pairs of wheels and axles in two bogies are steadier than those having two pairs in a

bogie and the other two in the tender frame. We have definitely found this to be so, and for this reason I suggest that we add the phrase : « For 8-wheeled tenders two bogies should be used. »

The President. — I will put to the Meeting summary 1 with the additional words proposed by Mr. Baumann : « For 8-wheeled tenders, it is recommended to utilise two bogies. »

— Summary 1 with the addition proposed was adopted unanimously.

We will now take *Summary 2 :*

Carriages for high speeds are preferably bogie vehicles. There is a marked tendency towards the use of long wheel base bogies.

Has anyone any remark to make ?

Mr. Renevey, Paris Lyons & Mediterranean Railway (in French). — It seems to me that the wording of this summary is rather too formal. I am not absolutely convinced that « the tendency towards the use of long wheel base bogies » is as marked as it says in the summary.

There are in fact administrations who have increased the wheel base of the bogies, but they are not the majority.

I propose to use a more moderate expression, such as « a certain tendency ».

The President. — In the German text it says : « a certain tendency. »

Mr. Renevey. — This is just what is wanted.

The President. — Does this Meeting agree that the summary be approved with the slight modification suggested by Mr. Renevey ?

— *(Unanimously adopted.)*

We will now take *Summary 3 :*

A high centre of gravity of the locomotive is an advantage as regards smooth riding. The question of security against the locomotive overturning has been satisfactorily solved everywhere.

Mr. Baumann (in German). — I agree with the French and English texts, but I think that the German translation is not sufficiently accurate.

Mr. Chantrell (in French). — The necessary corrections will be made.

Mr. Renevey (in French). — I would again ask that in summary 3 (French text) the word « chavirement » be replaced by « renversement ».

The President. — Are we in agreement to replace « chavirement » by « renversement » in the French text ? *(This was approved.)*

I will now invite the Meeting to vote on the text of summary 3 as given in the French version, the word « chavirement » being replaced by « renversement ».

— *(This summary was adopted in this way.)*

The President. — We will now take *Summary 4 :*

Generally speaking locomotive bogies are provided either with gravity or spring controlling gear. The initial centring force should be sufficiently high and not differ greatly in value from that of the final centring force.

Has anyone any remark to make on summary 4 ?

As nobody whishes to speak we will take it as *adopted.*

Summary 5. — Among the various methods of suspension for locomotives, the arrangement in 2 transverse planes, with the engine supported on 3 or 4 points, most satisfactorily ensures that there is sufficient static load on the guiding wheels when entering a superelevation incline on leaving a curve.

Summary 5 was adopted without remark.

Summary 6. — Security against derailment decreases as the diameter of the guiding wheel, the striking angle, and the coefficient of friction, increase; on the other hand a high value for the angle made by the outer face of the wheel flange with the horizontal increases the security. The value of this angle is however limited by the following considerations: *a*) more rapid wheel flange and rail wear; *b*) increased resistance on curves.

In order to reduce the coefficient of friction, it is desirable that some efficient and practical solution be found of the question of lubricating wheel flanges when running through curves.

Messrs. Chantrell and Baumann reported they agreed to this text.

Mr. Renevey (in French). — I think that if a locomotive builder read this text and applied it literally, he would use as the guiding wheel of the locomotive the smallest possible wheel, such as for example one of 20 cm. (8 inches) diameter.

I do not believe that this would be likely to prevent derailments. It is possible that a large wheel is more likely to derail on a straight line, on ordinary track, but there is not only the ordinary track, there are appliances, points and crossings, there are check rails, and for these parts of the track, there are other requirements to be met.

The proof is that the « Unité technique des chemins de fer » (Technical railway standards) which we all follow, requires for carriage wheels a minimum diameter.

The summary therefore appears to be in complete contradiction with the « Unité technique » and what relates to it; we should therefore say : « Security against derailment, *on the ordinary track*, diminishes with the increase... » which does not mean very much because we are obliged to assure safety just as much at the points and crossings as on the ordinary line; or we should suppress altogether the words : « the diameter of the guiding wheel... »

The President. — Mr. Baumann, have you any explanations to offer on this subject ?

Mr. Baumann (in German). — I quite understand Mr. Renevey's objection; however, I would like to point out that what has been given here as summary 6 is nothing else than the substance of the scientific formula which may perhaps replace the formula of Marié.

I do not share the opinion of Mr. Renevey who fears that for this reason very small wheels might be used, because the builder knows that he must have a certain wheel diameter, otherwise the leading wheels would heat and would only clear with difficulty the non guided parts of double turnouts. It is the rule to make the bogie wheels of such locomotives 990 mm. (3 ft. 3 in.) in diameter, i. e. in round figures 1 metre; there are as far as I am aware, no wheels less than 850 mm. (2 ft. 9 1/2 in.) in diameter in existence.

In my opinion it would leave a gap if we did not mention in the text every point that this new formula covers. I propose therefore to maintain my wording.

The President. — Mr. Renevey, do you still insist on the modification you have

suggested to this summary, in view of Mr. Baumann's explanation ?

Mr. Renevey (in French). — It was a remark that I thought useful to put before you. I also think that it is desirable to add the words : « *on the running line* » to show that it is to the normal track that this formula applies, and not to the whole of the track uniformly.

We look for safety; we look for it everywhere; it should not be said that Safety — with a capital S — i. e. the general safety of the railways, depends upon the diameter of wheels being as small as possible; this is not true; therefore let us say: « the safety on the running line. »

The President. — Mr. Renevey proposes therefore to add to summary 6 the words : « On the running line » after the word « decreases ».

Perhaps Mr. Renevey will make it clear what he means by running line.

Mr. Renevey (in French). — The running line includes all track that is outside the points and crossings.

The idea very briefly is that the safety is better assured on the running line, where there are no points, or crossings, etc.

Mr. Baumann (in German). — I am of the opinion that the text should be maintained without adding the proposed words. The safety of the locomotive must not be assured only on the running line but on any part of the track.

Mr. Renevey (in French). — That is the reason why I cannot accept, for example a wheel of 20 cm. (8 inches) diameter; the text does not consider safety in all cases, and I insist upon it being corrected.

What it says in fact is as follows : the diameter of the wheels should be made as small as possible; I cannot admit such a wording. There is a minimum below which it is not possible to go.

If we added a remark saying : However the diameter of the guiding wheel should have a minimum diameter of..., I would agree.

Mr. Baumann. — I am quite prepared to accept such a clause.

The President. — We will leave it to the Bureau to draw up the final wording of summary 6 taking into account the observations made. *(This was agreed to.)*

We can now take summary 7 :

Research work and trials, the results of which will possibly be communicated to the Congress are now being carried out on several railway systems on the investigation of the dynamic forces caused by the violent impact of the guiding wheels of locomotives with the rails and also on the determination of the lateral oscillations of carriage bodies at high speeds.

Mr. Chantrell (in French). — The summary proposed should evidently be modified as regards the passage : « ... the results of which will possibly be communicated to the Congress... » These words ought to be modified if not suppressed.

The President. — Has Mr. Baumann any remark to make on this subject ?

Mr. Baumann (in German). — I agree that these words should be suppressed, but it might be interesting to give you a few details about the tests which we have undertaken to get knowledge of the dynamic forces acting on the vehicle when running. You will no doubt deduce that

what we have found in our theoretical investigations on the statics of the support and all our conclusions therefrom can only have a relative value, as actually the elements of the problem are much more complex.

One of the reasons why we carried out these investigations was the derailment of a tender which remained unexplained; we wished to find out if the cause of the derailment was to be sought in the design of the tender.

For this purpose we examined, with the help of the Heinrich Herz Institute of Berlin, two 4-6-2 locomotives with their tenders at speeds of 10 to 80 km. (6.2 to 50 miles) an hour. The provisional investigation of the oscillograms taken during these tests was only possible a few days before I left for this session of the Congress. Several months will be needed to study the results of these tests; nonetheless I think it can safely be affirmed that only a beginning has been made, and that many other tests will be needed before we have more or less exact knowledge of what occurs on the vehicle when running. It is desirable that all the large railway companies should undertake tests of this kind.

As regards the method of construction of the 8-wheeled tenders, which among other subjects was the object of our experiments, we found that the tenders in which the four pairs of wheels and axles are mounted in two bogies are less subject to derailment than those carried on a four-wheeled bogie at the leading end, and two pairs of wheels mounted rigidly in the frame of the tender.

Contrary to our expectations, we found that the friction in the laminated springs in the equalisers, and in the spring shackles play a much more important part than has usually been admitted up to the present. One of the two locomotives was supported in two planes, the other in three. The tests carried out have not, however, revealed any appreciable difference in action. I would not, however, generalise this statement now, because it is a question of results obtained with two locomotives only.

The examination of the oscillograms enables us to see that during the passage of a one-sided difference in level at the speed of 10 km. (6.2 miles) an hour, the line of rails not lowered is submitted immediately and momentarily to a certain overload, and the locomotive leans heavily towards the side without load. The observations recorded confirmed what the static consideration made us foresee. At speeds of 60 to 80 km. (37.3 to 50 miles) an hour, this inclination towards the lower side only occurred 15 m. (49 feet) behind the drop in level, but the transverse inclination extended beyond the position of equilibrium; the one-sided lowering of the track set up transverse oscillations.

As soon as these dynamic actions took place, the calculated values on a statical basis underwent modifications. It appears essential to know more exactly the nature and order of magnitude of these variations. It would therefore be desirable that at the next sessions the Congress should deal again with this problem, other administrations having also carried out tests of this type on the dynamics of running vehicles.

Before a vote is taken on summary 7, I would like to stress again the fact that the majority of the summaries are based on purely statical investigations. I have also mentioned several times in my report that my conclusions had and could but have a purely static signification, seeing that we still do not possess sufficient numerical data on all the effects of friction and the mass actions.

Taking these considerations into account, I suggest that summary 7 be worded as follows :

« All these considerations only consider the question of security againts derailment from the static point of view. It is therefore desirable to note that some administrations have begun to study the dynamic actions occurring during the running of vehicles. The results of the tests made to date by the German State Railway Company appear to show that dynamic effects are only set up at speeds above 10 km. (6.2 miles) an hour; that they are more apparent on the straight than on curves with superelevated outer rails, and that the friction of the springs in their suspension, in the axle-box guides, and in the compensating levers, has the effect that the alterations in the pressure on the guiding wheel of the leading bogie, running over irregular track, are of about the same order of magnitude, whether the locomotive is carried on two planes at four points, or whether on three planes at 6 points. It would be premature to come to any conclusions.

« It would be well for other railways to carry out investigations into the dynamic forces which intervene in the guiding of locomotives, forces which are still generally unknown, and which ought to be known if it is desired to express the condition of safety against derailment by a formula. »

The President. — I will now ask the Meeting to vote on summary 7, suppressing the words : « the results of which will possibly be communicated to the Congress », and the addition of the words : « the Congress recommends the continuation of these studies and researches. » *(Approved.)*

The wording of summary 7, taking into account the remarks of Mr. Baumann, will consequently be as follows :

7. The preceding conclusion refers to the question of safety against derailment only from the static point of view. Research work and trials are now being carried out on several railways for the investigation of the dynamic forces, taking account of the friction in the suspension gear.

Owing to the importance of the problem, the Congress recommends the continuance of these studies and researches.

— *Adopted.*

The President. — We now have to consider the new text of summary 6 drawn up by the Bureau.

It is suggested in fact that we insert between the 1st and 2nd paragraph the following text :

« It must be understood that the diameter of the guiding wheel cannot be less than the limit imposed by experience. »

Mr. Renevey (in French). — This wording does not appear any too happy, because it appears to imply that practice is in contradiction with the calculations.

The President. — I think, in fact, that everyone will be agreed that conclusion 6 can be approved with the addition of the words :

« I must be understood that the diameter of the guiding wheel cannot be less than the limit imposed by the other elements considered. »

— *Summary 6 was adopted with the proposed addition.*

The President. — We will now take the second part of Question II relative to the *Track*.

The special reporter for this part is not attending the Congress; therefore if everyone agrees we will deal directly with the summaries. *(Agreed.)*

Summary 1 is as follows :

The computation of the strength of the railway track is especially a practical matter.

The experimental research work undertaken by certain railways ought, however, to be encouraged and followed with interest.

Special attention should be paid to all trials tending to the elimination of rail joints — the use of long rails, the welding of rails, etc.

Does any delegate wish to speak about this summary ?

Mr. Herwig, German State Railway Company (in German). — The methods of calculation employed by the railway companies in order to compute the strength of the track are based almost entirely on information of a statical nature; the dynamic influences have not been taken into account in most cases. The calculation of these influences by introducing into the formula some coefficient chosen more or less arbitrarily, as is often done, is insufficient.

The efforts of the various Administrations in order to find a formula the factors in which could not be disputed have led to the conclusion that the necessary elements can only be found by measuring the deflections, stresses, etc., in the track in service. An endeavour should be made to determine in this way the supplementary forces the different parts of the track are subjected to, by the speeds, the track irregularities, by the running over curves, etc.

The very promising trials carried out in this direction by the various railways should in any case be followed up, so that in the end it may be possible, thanks to the exchange of experience, to arrive at simple methods of determining the dynamic influences and also to arrive at a formula free from any objection.

The first part of summary 1, saying : « The computation of the strength of the railway track is especially a practical matter » does not mean very much. I suggest it be reworded as follows :

« The elements on which we base the calculation of the strength of the permanent way cannot usually be found only by trial, i. e. by measuring the loads and movements occurring in the track in service.

« The trials already undertaken in this sense on different railways ought to be followed up and helped on, and other measurements taken. »

Mr. Duchateau. — Would it not be possible to word the French text of the summary as follows :

« L'évaluation de la résistance de la voie ferrée est surtout d'ordre expérimental.

« On doit encourager et suivre avec intérêt les recherches entreprises sur certains Réseaux.

« Il faut prêter une attention particulière à tous les essais tendant à la suppression des joints — mise en œuvre de rails longs — soudure des rails, etc. »?

The English and German texts would then be made to agree with this text.

The President. — Do you agree with the summary under this form ?

— *Adopted.*

We will now take *Summary 2 :*

The present tendency is to diminish gauge widening and to ensure closer guiding of the vehicles by the track. Systematic trials, with this object in view, ought to be pursued.

Does everyone agree to adopt this text ?

— *Adopted.*

We will now take *Summary 3 :*

The rules used for determining the speed through curves, the superelevations and the transition curves between circular curves vary on the different railways. These factors, wich affect high-speed running through curves, could usefully be made the subject of further research work, which would take into account the forces called into play when the vehicles are running.

Mr. Tettelin (in French). — I do not wish to propose any modification of summary 3, but I should like to make a remark on the subject of a passage in Mr. Baumann's report which says, page 2357, that from the point of view of adequate stability it is desirable that the amount of superelevation should not be less than a given minimum, which according to the formula given would be : $h = 11.8 \frac{V^2}{R} - 90$; according to that, for a curve of 1 000-m. (50 chains) radius, a superelevation of at least 80 mm. (3 1/8 inches) would be required.

I would like the Meeting to know that on the French Nord Railway there are two curves of 945 m. (47 1/4 chains) radius, i. e. a little less than 1 000 metres, which have no superelevation, and which are run over at 90 km. (56 miles) an hour.

These two curves are the two branches of a symmetrical junction, and as the two branches are equally important, it is not possible to sacrifice one for the other in order to give the first a superelevation at the expense of the second; the result is that there is no superelevation at either of the two curves.

This junction is located at Creil, on the line from Paris; to the left the line goes to Boulogne, Calais, and Lille, and to the right to Brussels, Amsterdam and Berlin. The express trains, about 30 per day, run through these two curves without superelevation, at 90 km. (56 miles) an hour. No disagreable sensation has been experienced. This shows that the safety is not always compromised when the minimum superelevation fixed by Mr. Jaehn has not been given.

The President. — Mr. Tettelin, would you like Mr. Jaehn's report to be altered in this respect ?

Mr. Tettelin (in French). — No, Mr. President, I simply wanted to point out that this experimental fact shows that we must not be too precise in the practical summaries to be drawn from theoretical conclusions.

Mr. Duchateau (in French). — We will therefore simply reproduce the remarks of Mr. Tettelin in the minutes of the Meeting.

The President. — Are we agreed about the text of summary 3 ?

— *Summary 3 was adopted.*

We have now to examine the 4th and last summary :

Turnouts on high-speed tracks should be so laid out that no speed restriction will be imposed when they are run over.

Has anyone any objection to raise ?

Mr. Herwig (in German). — I think that the German translation does not agree with the French text. It is not solely a question of laying in turnouts, but more especially of their construction.

I therefore propose the following wording :

Turnouts on high-speed lines should be so designed that they can be run over,

even the curved sections, at a speed approaching as much as possible that authorized on the straight sections.

Mr. Duchateau. — That is what the French text says.

Mr. Hossu (in German). — I support Mr. Herwig's proposal. The turnouts should not only be laid in but built in this way. The two words ought to be used, and we should say :

« Turnouts should be so built and laid in that they can be run over at as high a speed as possible, i. e. as far as possible at the same speed as the running track. »

Mr. Duchateau (in French). — We are discussing in fact questions of translation, as the different texts do not exactly correspond; under these conditions it would be best to agree about the French text, which would then be translated into English and German.

Mr. Herwig (in German). — I should like to add after « établis »: « autant que possible » *(French text)*.

Mr. Duchateau (in French). — Personnally I think that as the text begins with the words « Il est désirable » this would be repetition.

Mr. Schutz (in French). — It appears that the French text is correct, as it says what Messrs. Herwig and Hossu wish. Are we in agreement to vote on the French text ? We will then translate this text exactly, with the word « établir » meaning both designing and laying. Mr. Herwig do you agree if we add in the French text : « autant que possible »?

Mr. Herwig (in German). — I agree.

The President. — I think we are now in agreement on the French text, provided the words : « autant que possible » are added. I will now ask the Meeting to express an opinion.

— *Summary 4 was adopted with this modification.*

Mr. Romero, Italian State Railways (in French). — I would like to say a word on the length of rails. During recent years the Italian Railways have used on lines with heavy traffic welded rails, 36 m. (118 feet) long, consisting of two ordinary 18-m. (59 feet) rails welded together.

By adopting separate fastenings of the rail on the bearing plate, and of the plate on the wooden sleeper, they have found on these 36-m. welded rails that the expansions and contractions under the influence of varying temperatures were very small, and this has made it possible for them to provide at the rail ends quite ordinary gaps.

Encouraged by these results, rails 36 metres long have recently been rolled without undesirable consequences.

Mr. Herwig (in German). — The German State Railway Company have used rails 60 m. (196 ft. 10 in.) long, and obtained generally good results. These rails were two 30-m. rails welded together.

Mr. Tettelin (in French). — I would like to point out that at the Madrid Congress equipment for revealing the internal defects of rails was mentioned; this equipment consists of a coach, electric generators, and contacts.

We have one of these sets brought over from America; at the present time it is being used to inspect the track of the French Nord Railway. If any Members of the Congress would like to have any

information on the subject of this apparatus, I am at their disposal to let them have it and to show them how the instrument works. I am also quite willing to give any details on the internal defects which we have found, three or four hundred in number, which is, as you see, a rather good harvest !

The President. — We have now come to the end of the work of the 1st Section, and I would like to thank the Meeting for the interest shown in our discussions. I would also like to acknowledge the valuable assistance the Secretaries have given us during the various meetings. *(Applause.)*

DISCUSSION AT THE PLENARY MEETING

held on the 30 January 1933 (morning).

H. E. Ibrahim FAHMY KERIM Pasha in the Chair.

General Secretaries : Messrs. P. GHILAIN, Youssef RISGALLAH Bey, Dr. I. G. LEVI and FOUAD HASSIB Bey.

Assistant General Secretaries : Sir Henry FOWLER and Mr. P. WOLF.

Mr. Ghilain, General Secretary. — We now come to the summaries of Question III, which have been published in to day's issue of the *Daily Journal of the Session.*

— *These summaries are read out.*

The President. — Are there any objections as regards the text of these summaries.

— *No comments.*

We shall consequently consider these summaries as ratified.

Summaries.

A. — The vehicle.

Weight of vehicles per axle, position of the centre of gravity, wheel arrangement, layout to facilitate running through curves.

« 1. For high-speed steam locomotives, « guiding by four-wheeled carrying bo- « gies is found to be the general practice. « Two-wheeled trucks are more rarely « used.

« High-speed electric locomotives have « four-wheeled carrying bogies, or bo- « gies with 2 carrying wheels and 2 driv- « ing wheels or two-wheeled trucks, or « a bogie for one direction of running « and a two-wheeled truck for the other, « or again two driving bogies.

« It is recommended that the vehicle « should be guided by the bogie centre « pin only, that a long rigid wheel base « be provided with as long a guided « length as possible.

« For 8-wheeled tenders it is recom- « mended to utilise two bogies.

« 2. Carriages for high-speeds are « preferably bogie vehicles. There is a « certain tendency towards the use of « long wheel base bogies.

« 3. A high centre of gravity of the « locomotive is an advantage as regards « smooth riding. The question of safety « against the locomotive overturning has « been satisfactorily solved everywhere.

« 4. Generally speaking locomotive bo- « gies are provided either with gravity « or spring controlling gear. The initial « centring force should be sufficiently « high and not differ greatly in value « from that of the final centring force.

« 5. Among the various methods of « suspension for locomotives the arran- « gement into two transverse planes, with « the engine supported on three or four « points, most satisfactorily ensures that

« there is sufficient static load on the « guiding wheels when entering the su- « perelevation incline on leaving a curve.

« 6. Safety against derailment de- « creases as the diameter of the guiding « wheel, the striking angle, and the co- « efficient of friction increase. On the « other hand the high value for the « angle made by the outer face of the « wheel flange with the horizontal in- « creases the safety. The value of this « angle is however limited by the fol- « lowing considerations : *a*) more rapid « wheel flange and rail wear; *b*) increas- « ed resistance on curves.

« It must be understood that the dia- « meter of the guiding wheel cannot be « less than the limit imposed by the « other elements considered.

« In order to reduce the co-efficient « of friction it is desirable that some « efficient and practical solution be « found of the question of lubricating « wheel flanges when running through « curves.

« 7. The preceding conclusion refers « to the question of safety against de- « railment only from the static point of « view. Research work and trials are « now being carried out on several rail- « ways for the investigation of the dy- « namic forces, taking account of the « friction in the suspension gear. Owing « to the importance of the problem, the « Congress recommends the continuance « of these studies and researches.

B. — The track.

Strength of the track, widening of gauge, radius of curves, superelevation, transition curves, points and crossings, check rails.

« 1. The computation of the strength of « the railway track is especially an ex- « perimental matter.

« Research work undertaken by some « Railways ought to be encouraged and « followed with interest.

« Special attention should be paid to « all trials tending to the elimination of « rail joints — the use of long rails, the « welding of rails, etc.

« 2. The present tendency is to di- « minish gauge widening and to ensure « closer guiding of the vehicles by the « track. Systematic trials, with this ob- « ject in view, ought to be pursued.

« 3. The rules used for determining « the speed through curves, the super- « elevations and the transition curves « between circular curves, vary on the « different railways. These factors, « which affect high-speed running « through curves, could usefully be made « the subject of further research work, « which would take into account the « forces called into play when the ve- « hicles are running.

« 4. Turnouts on high-speed tracks « should be so designed and laid out « that as far as possible no speed res- « triction will be imposed when they are « run over. »

Note by Mr. R. da Costa Couvreur,

Engineer, Inspector of Public Works, Portugal, formerly Chief Engineer (Way & Works) of the State Railways
Member of the Permanent Commission of the International Railway Congress Association.

The question of superelevation on curves, so scientifically treated in the valuable reports of Mr. Deyl, and Messrs. Baumann and Jaehn, has led the former of these reporters to make the following statements :

« The formulæ in use up to the present for the amount of the superelevation are based, either on the theorical formula derived from the centrifugal force, with certain reductions — the result of experience — or these formulae are purely empirical. » (Report by Mr. Deyl, *Bulletin of the Railway Congress,* November 1932, page 2209).

As a result of an investigation in wich the forces acting on the vehicle running through the curve are taken into consideration, Mr. Deyl has arrived at the formula (VII) page 2215, for use in the case of high speeds.

From this formula we get formula (X) page 2218, indicating for what various values of the radius of the curve, and up to what maximum speed, superelevation need not be used.

On the other hand, Mr. Jaehn, basing his arguments on the « Technical Conventions » of the German *Verein,* recommends that the superelevation be so arranged that it is not less than the limit given by the formula of page 2359 of his report (*Bulletin of the Railway Congress,* December 1932).

When considering the summary on this matter at the Cairo Congress, Mr. Tettelin called attention to the case of two curves of 950-m. (47 1/2 chains) radius on the Paris-Calais and Paris-Brussels line, which, without any superelevation, are run over by trains at a speed of 90 km. (56 miles) an hour, and thus showed in a practical fashion — thus confirming the conclusions of Mr. Deyl — that contrary to the limit fixed by the German *Verein,* superelevation is not absolutely indispensable in all cases.

The application of the formula of Mr. Deyl would not, however, theoretically confirm the safety in the case mentioned above, as the value obtained for the limiting speed would be at the most 77 km. (47.8 miles) an hour.

How can we reconcile the theoretical and practical results ?

The object of the present note is not to discuss either the absolute value or the relative value of the above statements, but only to recall to mind a paper presented by the late distinguished Portuguese Engineer, Mr. Xavier CORDEIRO, at the Paris Congress (1900) on the subject of superelevation, in which he put forward the following formula for calculating the superelevation :

$$h = 0.01575 \frac{l.\ V^2}{R} - l.\ F.$$

in which h = the superelevation,
l = the gauge of the track,
V^2 = the speed in km./hour,
R = the radius of the curve,
and F = the coefficient of adhesion,

deduced, taking into account the centrifugal and centripetal forces, the vertical component of the driving force, the weight of the train, and the friction of the wheels on the rails, and from which, like Mr. Deyl, Mr. Xavier Cordeiro drew the limiting value of the speed corresponding to zero superelevation, which would be for $F = \frac{1}{7}$

$$V = \sqrt{9.R}$$

If we apply this formula to the case indicated by Mr. Tettelin, we get

$$V = 92 \text{ km. (57.2 miles)},$$

a value which reconciles the facts given by Mr. Tettelin with theoretical safety.

* * *

While I make use of this opportunity for complimenting the Reporters on Question III at the Cairo Session, for the work they have presented, I think it is also my duty not to let us forget the memory of Mr. Xavier Cordeiro : he is one of the glories of Portuguese engineering, and his accuracy already recognised by his explanation of the case related by Mr. Le Chatelier at the St. Petersburg Congress of trains running without accident through a curve of 100-m. (5 chains) radius, in which the outside rail was lower than the inside rail is confirmed once more by the case quoted by Mr. Tettelin.

Lisbon, 23 February 1933.

[625. 111]

What kind of a grade crossing?

A resume of the experience of railway engineers with existing designs and of their search for a satisfactory form of construction.

(*Railway Engineering and Maintenance.*)

Does the wood plank crossing meet the demands of modern highway traffic or must it give way to some other form of construction ? If the latter, what form shall it take and what materials are best adapted for this purpose ? These are only a few of the many questions that have arisen among the railways with respect to the 238 000 grade crossings which they are required to maintain across their tracks, by reason of the revolutionary changes that have been taking place in recent years in both the volume and character of highway traffic.

In the main, railway engineers are agreed that the untreated wood plank crossing has outlived its usefulness for heavily traveled highways, but the changes in highway traffic have occurred so rapidly that there has been little opportunity as yet for crossing design or maintenance practices to keep pace with them. As highway vehicles have increased in speed and weight, numerous forms of construction have been devised to meet the constant demand for better crossings. Yet, to a very large extent, the present standards of crossing construction are not satisfactory, as is clearly indicated by replies that have been received to a questionnaire on this subject from chief engineers and engineers maintenance of way of more than 40 representative roads reaching every section of the country and including more than 150 000 miles of lines. It was equally apparent from the replies that, without exception, these officers are deeply interested in finding a solution of the problems of grade-crossing construction and maintenance, and that they are now giving these matters most serious consideration.

Fig. 1. — The untreated wood-plank crossing harks back to the horse and buggy days.

With only a few exceptions, these officers advise that they do not consider their present standards satisfactory, although some of them have been adopted as recently as four or five years ago and others within the last year. Nearly all of those who replied said frankly that they are searching for a form of construction that will meet the requirements of present-day highway traffic; that will have a relatively low cost of maintenance, all factors considered; that will require a minimum of attention; and that will remove or reduce the restrictions to track maintenance, which are imposed by some of the forms of construction now available.

Uncertainty and confusion prevail.

Some of the crossings that have been tried have failed to stand up under the wear and tear imposed by highway vehicles. Others have resisted this traffic but have gone to pieces by reason of the movement of the rails under cars and locomotives. Still others that have been satisfactory in these respects have not possessed the proper traction, have required excessive maintenance, have interfered too much with track work or have been considered too expensive. To further complicate matters, much rerouting and diversion of highway traffic have occurred as a result of improved highway construction, so that relatively unimportant crossings have suddenly been called on to carry traffic of greater volume, speed and weight. As a result of these changing conditions and the experience thus far in trying to keep abreast of them, there is much uncertainty and confusion among railway officers as to the proper solution of the problems of grade-crossing design and maintenance.

Indicative of this uncertainty, 21 of the officers replying to the questionnaire stated that while the wood plank crossing is still their standard form of construction, this form of crossing is not satisfactory and that they have deviated from the standard to make extensive installations of other types in an effort to find one or more that will meet their needs and at the same time demonstrate ultimate economy. Five roads have standardized on some form of bituminous materials and two have adopted precast concrete plank as standard. Five roads stated that they have no standard but are installing crossings of the types that seem best suited to the conditions surrounding each individual case. Similarly, eight roads reported that owing to the varied requirements in different states they have more than one standard. Some reported from five to nine types in use, not all of which have been standardized, however. Several roads advised that certain forms of construction that are approved by the highway department of one state may not be permitted in another.

Standards not being followed.

Still further illustrating this confusion, two roads stated that while they have standards, they are not conforming to them. W. A. Spell, chief engineer of the Atlanta, Birmingham & Coast, expressed the uncertainty with which railway officers view the situation in his statement that « while we have a standard highway plan, I do not believe that there is a single crossing on our road that is built in accordance with it ».

It is of special interest to note that while many of the roads have not changed their standards from those of 20 years ago and are still installing crossings in accordance therewith, all but a few are retaining them only because they have not yet found a form of construction which they are willing to adopt as a standard. Furthermore, several of the roads that have adopted later standards indicated that they have done so only tentatively and that they are continuing their search for still more satisfactory forms of construction. Practically all of

the roads reported test installations of various types. Thus, A. Anderson, engineer maintenance of way of the Chicago, Indianapolis & Louisville, listed 16 different forms of construction that are now under test on that road. In like vein, C. T. Jackson, assistant engineer maintenance of way of the Chicago, Milwaukee, St. Paul & Pacific, reported that this road has about 30 test crossings installed under a wide variety of railway and highway traffic conditions. W. G. Brown, engineer maintenance of way of the Florida East Coast, also reported that « we are experimenting with several types ».

Some consider wood plank best.

Most, but not all, agreed that the wood-plank crossing has outlived its usefulness and should be superseded, except possibly at highways of light traffic, by crossings of more modern design. Yet, the wood plank crossing still predominates in all sections of the country and on all but a few roads, and this type of construction is still in service on some of the busiest crossings.

Voicing the view point of those who do not believe that a better crossing has yet been devised, Armstrong Chinn, chief engineer of the Alton, said that « we have found that we can install a smoother, better-riding and quieter crossing with plank than with any other material. In view of its low initial cost, the ease with which it can be installed and renewed, and the facility with which it can be taken up and replaced to permit work on the track, we expect to continue the plank crossing for some time to come ». In like manner, P. C. Newbegin, chief engineer of the Bangor & Aroostook, states that « we use plank crossings almost exclusively, for they have given satisfaction and appear to meet all requirements as we have very light traffic on our highways ».

Fig. 2. — Creosoted gum crossing.

There are those, however, who believe that the untreated plank crossing no longer meets modern service and economic requirements and have substituted, therefore, treated timber of certain species, especially gum. Among these is G. W. Harris, chief engineer of the Atchison, Topeka & Santa Fe, who has standardized on treated timber construction and uses creosoted black gum principally. Mr. Harris, stated that « this standard was adopted in 1928 and has ren-

dered very satisfactory service under modern highway conditions. It is an improvement on our previous standard, because we frame the timber before treatment and use black gum, which has excellent wearing qualities. In my view, this is the best form of construction, based on first cost and the fact that it can be placed, repaired and renewed by section forces without special supervision or special tools ».

Of the same mind is A. N. Reece, chief engineer of the Kansas City Southern, who advised that « our standard, which has been in effect for about 15 years, is 4-inch creosoted gum crossing plank, fastened with lag screws », and added that « there has been no change or deviation from this standard in recent years except to make some experimental installations of other types. Our experience has not been sufficient to say with any degree of certainty what the ultimate life will be. We have many crossing planks that have been in service for 14 years and are still in reasonably good condition ».

Likewise after describing the experience of his road with several types of permanent crossings, C. S. Kirkpatrick, chief engineer of the Gulf Coast Lines, asserted his preference for creosoted

Fig. 3. — A four-track rock asphalt crossing.

gum plank which that road has adopted as its standard, « because they are easily removed when necessary to make repairs. When worn, they can be built up by placing an asphalt wearing surface; or this can be done when they are first laid. On crossings involving multiple tracks, we make the planking continuous and find it easy to take out a few planks when they become worn, thus spreading the cost over a longer period. An attractive feature of this type of crossing is that it costs, including a wearing surface of asphalt, about $ 3.75 a running foot of track ». In a similar vein, J. E. Willoughby, chief engineer of the Atlantic Coast Line, commented that « where the traffic is sufficiently dense to require the highest type of crossing, the most desirable form of construction is creosoted plank ».

Rock asphalt.

One of the early substitutes for plank was rock asphalt, of which 18 roads reported installations covering periods of service up to 10 years. A number of these roads called attention, however, to

the importance, with this type as with other bituminous materials, of placing the track on a solid foundation at the time of installation and so maintaining it as to reduce to a minimum the movement of the rails under passing wheels and the breaking up of the crossing materials adjacent thereto. Mr. Anderson's description of the methods employed on the Monon when installing all types of bituminous crossings, is typical of those that are followed on other roads. He said that « we have made it a practice on every new crossing first to clean out the old ballast and put in a good base of crushed rock, which is allowed to run awhile under traffic. We then replace all ties with new creosoted ties, install tie plates and tamp solidly, generally with tie tampers, fill with crushed rock to the top of the rail and allow this, in turn, to run awhile. Later we apply the surfacing material. If the track is not on a solid foundation, there is a tendency toward more or less vertical movement under passing trains, which shakes the surface material loose, causing holes to develop ».

Based on the experience of his road, C. S. Robinson, engineer maintenance of way of the Maine Central, reported that « for our first-class crossings we have

Fig. 4. — A bituminous crossing with a flangeway guard.

installed various types, including rock asphalt and other bituminous materials. The installation costs do not vary widely, rock asphalt showing the lowest labor expense. For ease in repairing damage caused by highway traffic, rock asphalt has many advantages ».

« On the Southern Pacific », according to E. A. Craft, engineer maintenance of way of the Texas and Louisiana lines, « installations have been made of various forms of rock asphalt and asphalt macadam. Rock asphalt crossings, if provided with a good solid base, can be expected to last from 10 to 20 years with minor surfacing repairs from time to time. This type must be destroyed, however, when tie-renewal or surfacing is required ». According to J. A. Peabody, engineer maintenance of way, the Chicago & North Western has also had rock asphalt crossings in as long as 10 years.

« During the last 12 to 15 years », said C. B. Hoffman, Jr., engineer maintenance of way of the Western Maryland, « we have constructed approximately 200 permanent crossings of various materials. Our present standard is rock asphalt over well-compacted crushed stone. We have made no changes since this standard was adopted three years ago, but we intend to install an additional line

of rail on each side of the running rails and 12 inches therefrom to lessen the damage to the crossings from the crowding action of vehicles ».

Other roads advocate bituminous materials.

Experience has led other roads to believe that under the present development of grade crossing construction, the bituminous type most nearly meets their needs. This form of construction falls into two classes, the penetration type, in which the base, usually crushed stone or slag, is placed and consolidated, after which the bituminous compound is spread over the surface and allowed to filter through the mass for the two-fold purpose of acting as a binder and providing a wearing surface; and the premixed type in which the aggregate and binder are mixed before application, commonly on the site of the crossing. Both types are used with or without flangeway guards as conditions seem to warrant.

In general, the penetration type of bituminous crossing is the least expensive to install, often costing less than untreated plank, and, in many situations, lasting from 3 to 10 years. According to Mr. Anderson, « the Monon has found that it can be made practically permanent if patched as soon as the need for repairs arises ».

Other roads prefer the premixed type. For example, Earl Stimson, chief engineer maintenance, advised that « on the Baltimore & Ohio we have 6 798 highway grade crossings, of which 95 % are bituminous concrete, 3 % are armored concrete slabs, and the remainder consist of plank or old-rail construction. We have been installing the permanent types over a period of 13 years and have reached the point where we now construct plank or rail crossings only where demanded by local authorities ».

Another road that has standardized on bituminous materials, the Delaware, Lackawanna & Western, has many crossings of this type in service, concerning which G. J. Ray, chief engineer, reported that « we have used mastic crossings extensively and find them far superior to plank. They afford the roadbed almost complete protection from rainfall, since little or no water can get through them when properly laid. For this reason, it is less difficult to keep the track in good condition ».

Using bituminous materials exclusively, G. A. Phillips, chief engineer of maintenance of the Lehigh Valley, replied that « all of our crossings are of oil and stone construction, although we embed rails in some of those carrying heavy traffic. We believe that this construction is economical from the standpoints of both installation and maintenance, and that in the long run it is the least expensive type ».

Norfolk and Western likes bituminous type.

The Norfolk & Western, as reported by W. P. Wiltsee, chief engineer, adopted a bituminous type of crossing about 10 years ago because « this type of crossing is easily altered, widened, etc., and the construction varied to meet almost any estimate of cost or density of traffic. In this 10 years, we have installed more than 1 000 crossings of this type ». The Boston & Maine has also installed approximately 300 crossings of this design within the last few years.

Having abandoned wood plank as its standard, the New York, New Haven & Hartford, according to E. E. Oviatt, chief engineer, « began about 1920 to install bituminous materials, since which, up to 1 January 1933, we have replaced 995 plank crossings under a wide variety of highway and rail traffic. Our experience has proved this to be a desirable form of construction, but the results depend on the care taken in making the installation and whether it is properly maintained thereafter ».

On the Peoria & Pekin Union, « a cin-

der-asphalt mixture has been used with marked success », according to E. H. Thornberry, chief engineer, « and is holding up remarkably well ». Another who commented on the use of bituminous construction was E. M. Hastings, chief engineer of the Richmond, Fredericksburg & Potomac who believes that « bituminous materials, if well put down, give the most desirable crossing from the standpoint of highway traffic, but are difficult to maintain next to the rail ».

When installing either rock asphalt or other bituminous crossings, some roads compact these materials snugly against the running rails, while others lay planks next to the rail to provide a flangeway, as in a plank crossing. Many of the roads are turning more largely, however, to specially designed metal flangeway

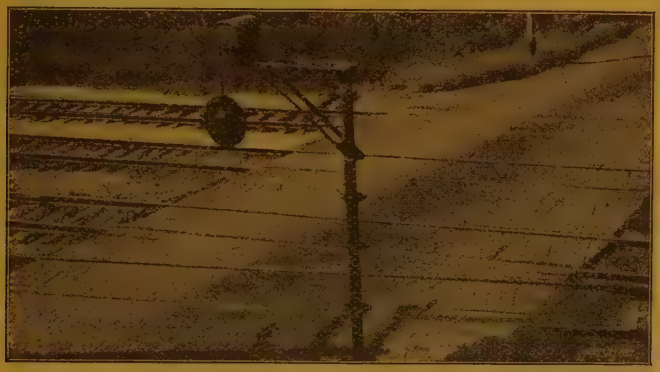

Fig. 5. — Preformed asphalt plank on a four-track crossing.

guards and find this the most effective means of prolonging the life and smooth-riding qualities of these types of crossings, individual roads having more than 75 000 linear feet of such construction in service. Flangeway guards for this purpose are of both open and closed-through designs, the former permitting stones and other small objects in the flangeways to fall through, while the latter are intended to protect the ballast and subgrade from rainfall. In some instances a similar device is used also outside of the running rails, thereby protecting the wearing surface both inside and outside from damage occasioned by the vertical movement of the rails. Typical of practices with reference to this detail of crossing design, W. P. Wiltsee, chief engineer of the Norfolk & Western, advised that « we install flangeway guards next to the running rails for the heaviest traffic, but do not use them for crossings of light traffic ».

Preformed asphalt plank.

Somewhat akin to the bituminous crossings are those of preformed asphalt plank, of which 12 roads reported installations. Unfortunately, some of the earlier installations of this type failed to meet expectations, the material being so plastic that it flowed under traffic. Later changes in the method of manufacture have improved the product, however, and A. F. Blaess, chief engineer of the Illinois Central, reported crossings of this type that have been in service six years, which compare favorably with other types on this road. In commenting on the probable life of the different types now in use on that road, including asphalt plank, Mr. Blaess said, « with

respect to service life, the performance of the different types of crossings mentioned has generally been quite satisfactory, although the length of time since they were installed is not such that I would care to predict an ultimate service life for any of them ».

Another road reported that preformed asphalt plank gives excellent service on crossings that can be left undisturbed for a long period, but did not recommend them for crossings where they must be taken up in whole or in part at frequent intervals. In this connection, several roads reported installations of this material for the wearing surface of overhead highway bridges, saying that it had been very satisfactory in this application, while others have used large amounts as protection for waterproofing.

Armored crossings are popular.

As is to be expected where so much uncertainty has existed and such active efforts have been made to find a satisfactory form of crossing construction, many roads have endeavored to develop designs of their own. In doing this, a large number have installed what has come to be known as the armored type.

Fig. 6. — Precast concrete plank.

This consists of a series of second-hand or scrap rails set workway parallel to the running rails to fill the space between them, and in some cases extending also to the ends of the ties, while in others, wood plank or other materials are placed outside of the running rails. The spaces between the rails are filled with such loose materials as cinders, broken stone or gravel, with concrete or with some bituminous compound.

Nineteen roads reported installations of this type, some of them indicating that it is satisfactory and that a large number of these crossings are in use, while others have found it unsatisfactory and have discontinued its use. Peculiarly enough, however, some of the roads that have been most active in their efforts to find a solution of the grade crossing problem made no mention of having used this type.

Speaking for the Alton, Mr. Chinn said that « for a while we installed rail-type crossings. They were satisfactory for crossings of approximately 90°, but did not prove to be very good for more acute angles, since there was a tendency for wheels to catch in the spaces between the rail heads and skid. Neither were they satisfactory from the standpoint of maintenance, since too much labor was

required to take them up for tie renewals, rail replacement, surfacing and lining ».

« On the Central of Georgia », said C. E. Weaver, assistant general manager and chief engineer, « we have adopted no specific type of crossing construction as standard, since the requirements of different localities and conditions do not permit. In recent years, however, we have confined ourselves rather generally to the use of the scrap-rail type of crossing, which has been satisfactory in every instance. During the last 5 1/2 years, 43 crossings of this type, embracing 98 tracks, have been installed. »

Other comments.

H. R. Clarke, engineer maintenance of way of the Chicago, Burlington & Quincy, advised that « this type is considered the most economical and is largely used ». Likewise, the Rock Island has had a favorable experience with this type, for as explained by W. H. Peterson, chief engineer, « where the track has been well surfaced and the drainage placed in good condition prior to installation, this crossing requires little maintenance for several years ». On the other hand, Mr. Kirkpatrick reports that it has been the experience of the Gulf Coast Lines that « the T-rail crossing is very good where the rail traffic is light and the vehicular traffic is heavy, but that where both are heavy these crossings heave and are not satisfactory ». According to Robert Faries, assistant chief engineer-maintenance, this type has not been satisfactory on the Pennsylvania, since « this construction is quite expensive, becomes rough when the bituminous material wears down, and cannot be removed readily to permit track work ». « On the St. Louis-San Francisco », said Col. F. G. Jonah, chief engineer of this road, « the old-rail type is generally installed at heavy-traffic streets and highways, regardless of traffic on the railway. This is practically everlasting, so far as the rail wearing out is concerned, but it must be taken up from time to time to permit resurfacing the track ». Among other users of this form of construction, the Baltimore & Ohio has 200 crossings in service.

Precast concrete slabs find favor.

While precast concrete slabs are reported to be standard on only two of the roads under discussion, they are used extensively on a few others and to a limited extent on some of the remainder. The extent to which this form of construction is used is indicated by the fact that more than 1 000 crossings have been installed of slabs from the plants of a single manufacturer. The oldest crossing of this type was reported by R. P. Fors-

Fig. 7. — Precast slabs enclosed in steel channels.

berg, chief engineer of the Pittsburgh & Lake Erie, who said that « a concrete plank crossing was placed over a switching track in 1914 and is used by passenger automobiles and pedestrians. Several of the slabs were broken by a derailed car in 1919, but the crossing is still in place and after 19 years' service is in fair condition ».

Erie gives up wood plank.

Typical of a number of roads that have changed their standards in an effort to keep pace with highway traffic, the Erie, according to J. C. Patterson, chief engineer maintenance of way, « had given up the use of wood plank and for a number of years prior to 1928 had used a bituminous concrete on heavy-duty crossings and rock asphalt on the remainder, except in cities where regular asphalt construction was used to conform to the local paving. In that year, we began to use precast concrete slabs and up to the present, whe have installed 185 of this type, besides 8 cast-iron and 1 steel crossing. We are still using the bituminous concrete for all but heavy-duty crossings ».

« Concrete slab crossings provide a smooth-riding surface for highway traffic, while they permit better and more economical track maintenance than any other type we use. We have installed 75 of these crossings since 1927 and consider them permanent as Class I construction », said A. C. Harvey, chief engineer of the New York, Chicago & St. Louis, who added, « it has been our observation that both the public and public officers prefer this type to our other forms of construction, and our experience leads us to believe that the concrete-slab crossing is preferable in the majority of cases ».

« Owing to our belief that the rapid development of highway traffic has introduced problems as yet unsolved », said Mr. Peterson of the Rock Island, « we have not yét developed a standard for so-called permanent highway crossings. While we still use wood plank, principally because of its cheapness and serviceability where highway traffic is light, we have installed many other types, among them the concrete slab. A number of this type, made up of sectional units, have been placed under heavy highway traffic, some having seen service up to four years. They are giving good service and have not as yet required any maintenance. This type can be made practically water tight. If properly installed, it has the added advantages of providing a smooth surface and can be easily removed to permit track maintenance or the relaying of the rail. As against this, this type requires the renewal of the ties and ballast, and thorough tamping, as well as particular attention to drainage when the installation is made, to avoid any undue increases in track maintenance ».

That details of construction may make considerable difference in the results obtained from this type, as well as others, is indicated by W. J. Backes, chief engineer of the Boston & Maine, who said that « whe have two test crossings of concrete plank; in the first, the slabs were made with square edges and angle-iron protection at the corners, which has not worked out to good advantage. The second crossing, which has been in service about two years, was installed with concrete plank having rounded edges and no angle irons. So far this crossing has been very satisfactory ».

Monolithic concrete construction

In their search for a satisfactory form of crossing construction a number of roads have visualized the possibilities of monolithic concrete construction. C. E. Weaver, of the Central of Georgia, stated that his road has constructed crossings of this type, as well as with a brick surface on a concrete base, but gave no data as to the service they have rendered.

« In many cases », said H. R. Clarke of

the Burlington, « where a highway crosses a yard or sidings, the tracks are first placed in first-class condition as to ties, etc., and are then concreted in across the highway. This construction is also followed sometimes on very light branch lines. These crossings have already given several years service and present reports indicate that all of them are still in an entirely satisfactory condition ».

A somewhat more elaborate form of construction, in which the concrete extends to a depth of two feet or more below the top of the rail, was reported by P. D. Fitzpatrick, chief engineer of the Grand Trunk Western, who reported that, in conjunction with the installation of concrete slab construction in main lines « on sidings and certain of our light-traffic lines where the highway traffic is heavy, we have resorted to a monolithic concrete-encasement type of crossing which has proved to be quite satisfactory. An obvious disadvantage of this construction is that the track rails are embedded, which increases the amount of maintenance adjoining the crossing to prevent damage to the rail ».

Still another type of crossing construction that is receiving increasing attention, not only with respect to the number of roads on which they have been applied, but also as to the number of installations, is the metal crossing of either steel or cast-

Fig. 8. — A monolithic concrete crossing.

iron sections. Twenty-one of the roads replying to the questionnaire reported installations ranging from one or two to as many as 50, involving up to 13 tracks for a single installation. Incomplete records show more than 500 installations of this form of construction, aggregating more than 20 000 linear feet of track, or nearly 4 miles. Commenting on the experience of the Chicago & Illinois Midland, which operates through a section of the country that has recently seen a large amount of highway construction, C. H. Paris, chief engineer, said that « during the last six years we have installed 50 so-called permanent highway crossings of both metal-plate type and rail construction, usually in connection with the construction of hard surfaced roads or of paved streets. Our oldest installation has now been in for six years and is in excellent condition. The only maintenance so far required has been the renewal of the untreated timber shims. We now use only treated shims ».

With respect of this type, Mr. Peterson said that « we have installed a number of all-steel crossings of various designs and find that they stand up well under traffic. They have the disadvantage, however, of not being water tight and many of them are subject to corrosion from brine drippings. Most of them come in sections and have the advantage, as

compared with the armored (rail) type, of not requiring complete removal to permit tie renewals and surfacing. On the other hand, the better designs are more expensive because they are heavily reinforced to prevent breakage ».

« In the period between 1924 and 1931, both inclusive, the Southern Pacific installed 4 267 linear feet of cast iron crossings », said Mr. Craft. « They have been employed only at intersections with heavily traveled city streets or important highways. They have now been in service up to nine years and there is no indication as to how long they will last, as all are in good condition, but we believe that a service life of 40 years is a reasonable estimate. Obviously, however, repairs will be necessary from time to time with respect to the wooden wedges, screw spikes and other accessories. This type costs more than others in the first instance, but compares favorably in this respect when reduced to an annual cost basis, particularly under conditions imposed by heavy street and rail traffic. »

Reviewing his experience with this type of crossing, Mr. Clarke said that « on heavy traveled highways, particularly on hard-surfaced streets and roads, the Burlington uses three types of metal crossings, the armored or rail type, and rolled steel plates or cast steel, the latter two being employed where train speeds are such that the armored type is not considered desirable because of the difficulty of leveling and smoothing the track through the crossing ».

Fig. 9. — An armored or rail crossing.

Costs of installation and maintenance.

While the general relation between the costs of installation for the various types of crossings that have been mentioned seem to be fairly well maintained as between roads and for the group as a whole, the costs for any type vary over a relatively wide range when compared individually. This can be explained in part by differences in the local costs of the constituent materials or in the prices quoted by different manufacturers for their products, and by variations in the design for the same type, which often cover a wide range. These factors do not, however, fully account for all of the differences that were shown, since different roads reported rather wide variations for substantially identical forms of

construction, indicating differences in the methods of computing the completed costs, some roads apparently including the cost of conditioning the track preparatory to making the installation, while others did not.

Based on the figures given, a completed crossing of untreated wood plank varies from $ 1.50 to $ 3.75 per linear foot of track, but with the greater number between $ 1.75 and $ 2.50. Similarly, costs for treated plank vary from $ 2.06 to $ 5.56. With both materials, however, much of the difference in cost is explained by the woods used, including yellow pine, black gum, Douglas fir, Port Oxford cedar, red oak and white oak, the distance from the source of supply and, for treated material, the character of the treatment.

Cost of rock asphalt.

Rock asphalt was reported to cost from $ 0.77 to $ 4.50 a track foot, but here again the design of the crossing and the methods of installation are important factors in determining the cost. The same

Fig. 10. — One design of a cast iron crossing.

is true of other bituminous materials, including both the premixed and penetration types. This range extended from $ 0.61 a running foot of track to $ 6, the cost in some cases including the flangeway guard, in others excluding it. Premolded asphalt plank showed the narrowest range of any of the materials for which figures were given, being from $ 9.47 to $ 11 a foot. This may be due in part, however, to the fact that fewer roads gave cost figures for this material.

Rail, or armored, crossings showed nearly as wide a variation as other types, ranging from $ 4.04 to $ 11.74 a foot, this variation being nearly as great on individual roads as for the group as a whole. The factors which affect the cost of this type are the weight of the running rails, the care with which the installation is made, the amount and importance of the traffic over the crossing during installation, the character of the filling that is placed between the rails and whether the charges for the rails are based on second-hand or scrap prices, or whether, as is done in some cases, no charges are assessed, the rail being carried in a suspense account.

Precast concrete slabs and monolithic

concrete construction showed similar variations, ranging between $ 6.50 a foot of crossing and $ 11.25 for the former and from $ 3.92 to $ 10.25 for the latter. Here again the design must be taken into account, as well as the charges for preliminary track work, in attempting to analyze the costs of these crossings.

Most expensive type.

According to the information furnished, the metal type, including cast iron and steel, is the most expensive with respect to original cost, but as explained by Mr. Craft, most or all of this difference is wiped out when the different types are put on an annual cost basis. As given, the cost for metal crossings ranges from $ 12 to $ 17 a foot of track. This is another example of the fact that differences in design and of methods of computing the completed cost are, in themselves, responsible for much of the variation that is shown.

No road gave definite figures as to the cost of maintenance of its crossings. There was general agreement, however, that maintenance is lowest for the metal and concrete slab types and that practically no maintenance is required on monolithic concrete crossings, but slightly more attention must be given to the track adjacent to the latter. While current maintenance is about the same for the armored type as for metal and concrete slabs, this type has the disadvantage that considerable expense is involved in removing and replacing it when track work of any kind is required.

Fig. 11. — A rolled-steel crossing over 12 tracks.

A number of roads said that only a negligible amount of maintenance is required on rock asphalt and other bituminous crossings, provided small defects are repaired as soon as they become apparent. Others reported that the maintenance on these types is relatively high. The use of flangeway guards, the solidity of the track, particularly with respect to vertical movement, and the severity of winter temperatures are, of course, important factors in determining the cost of maintaining these types.

The replies indicated substantial agreement in the conclusion that untreated plank crossings require the largest amount of maintenance and that this cost is greatly out of proportion to the original cost of installation, often making this

Fig. 12. — A second design of a cast iron crossing.

type the most expensive when put on an annual-cost basis. On the other hand, the situation is reversed where creosoted timber having high resistance to wear is in use. While, in general, these crossings require more maintenance than some of the more permanent types, this cost is still relatively low, and on the annual cost basis compares favorably with other types. Confirming this conclusion, A. Montzheimer, chief engineer of the Elgin, Joliet & Eastern, reported that « creosoted plank crossing is very satisfactory with respect to the cost of both installation and maintenance ».

Considerations affecting selection of type.

Two questions were asked in the questionnaire as to the considerations that influence the selection of the type of construction to be used at any crossing. With few exceptions the answers were that the density and character of the highway traffic are the most important considerations, particularly as they affect the permanence of the crossing. Coupled with this, however, is the smoothness of the surface. In other words, it would not be considered expedient to install a crossing at an important highway, regardless of cost, which would last only a year or two, or one on which a smooth-riding surface could not be maintained.

Next in the order given was ease of maintenance, referring both to the crossing itself and to the facility with which the track can be kept in surface and line. It was mentioned repeatedly that the design should be such that these operations can be accomplished without impeding either highway or rail traffic..

As collateral reasons, the type of pavement adjacent to the crossing, the specific requirements of municipalities, sometimes by ordinance, and the preference of highway officiers were given as having a direct influence on the selection. Some roads also differentiate between streets and highways upon which high-speed passenger vehicles predominate and those carrying heavy trucking traffic. Several roads mentioned the fact that the angle of the crossing is the deciding factor, since some types are not suitable for acute-angle crossings. Again, some types of construction give excellent results where the rail traffic is comparatively light, but fail when applied to crossings which must carry a heavy-tonnage or high-speed rail traffic, or on crossings which must be surfaced and lined frequently. One road called attention to the fact that no satisfactory design, other than plank, has yet been worked out for those situations where the roadway crosses a turnout.

It should not be assumed from the

foregoing that either original cost or ultimate economy is ignored in making these decisions, since there was scarcely a reply that did not stress these considerations. It is evident from the discussions that railway officers are as deeply interested in matters of cost and economy as in any other feature of the crossing problem, and most of them said so explicitly. They recognize, however, that the better and more permanent types of construction will, in general, be more expensive in first cost than those of lower quality and of shorter life, and that low first cost does not necessarily imply ultimate economy. As an illustration of this thought, J. R. W. Davis, chief engineer of the Great Northern, said that « the greater the density of highway traffic, the larger the investment in crossing construction that is justified ».

Safety was frequently mentioned also as one of the factors which must be given consideration. While most of the construction in common use is considered satisfactory in this respect, several instances were cited in which serious hazards were involved. This seems to be particularly true of wood crossing plank, as was illustrated by the comment of

Fig. 13. — A pressed-steel crossing.

R. G. Kenley, chief engineer of the Minneapolis & St. Louis, who said that « crossing planks spiked to the ties do not make the safest crossing. We have had loose planks cause havoc with passing trains. We have also paid claims for damaged automobile tires by reason of spikes and loose planks ». Improper flangeway design was mentioned as a potential source of danger with some types, and the raising of parts of the crossing by reason of snow crowding underneath from the flangeways was also given as a source of serious danger.

Attitude of public and public officers.

Since highway grade crossings are constructed and maintained solely for the convenience of the public, the attitude of public officers and of those who use the crossings becomes a matter of consequence in the consideration of the problem. For this reason, those railway officers to whom the questionnaire was sent were asked to discuss this attitude with respect to the different types in use and as compared with previous types. Some roads replied that the public is little concerned as to the type so long as smooth-riding crossings are maintained. H. S. Clarke, engineer maintenance of way of the Delaware & Hudson, among others, reported that he had been commended by public officers and automobile associations as a result of using certain types. Several roads reported re-

quests from public officers for the installation of certain types that they had seen elsewhere. Mr. Robinson said that in the territory served by the Maine Central, « the public is following with interest the efforts to improve grade crossing construction and increasing criticism is received if the railway's accomplishment fails to keep pace with improved highway construction or attain the high standard demanded ».

Mr. Patterson said that it had been the experience of the Erie that « where one modern crossing is constructed in a town, there is immediate agitation for similar treatment at every other crossing in the municipality ». E. L. Crugar, chief engineer of the Wabash, said that « there is a growing inclination on the part of city, county and state officers to pay the entire cost of the material required to install certain types of crossings, usually concrete plank or monolithic concrete. In some sections, public officers will also maintain certain types gratis or for a nominal charge ». It is the experience of Lem Adams, chief engineer of the Union Pacific, that « the planked crossing is a source of constant complaint from the public, but with the installation of permanent crossings such complaints automatically cease. Such installations undoubtedly do much to improve public opinion ».

One of the most interesting comments on this phase of the subject came from Bernard Blum, chief engineer of the Northern Pacific, that « one of the strong arguments we have had for the installation of permanent crossings has been the attitude of the public with respect to them as compared with grade eliminations. In several instances where there has been agitation for a separation of grades, the installation of a concrete wearing surface has caused this agitation to cease.

What the railways have learned.

What have the railways learned from the intensive study they have given to the crossing problem ? Have any conclusions emerged from the performance of the various types they have installed ? In general, the replies indicated that railway officers are still open-minded as to the final solution of the problem. Although they indicated a trend toward certain conclusions, even though these opinions were by no means unanimous. The first was that crossing construction should be graded to conform to the density and character of the travel on the highway; in other words, the best form of construction available should be used at the busiest crossings, the less expensive design can be applied to secondary crossings, while the least expensive should be used at those of least importance. The second is that the construction which is most likely to survive will be that which shows the greatest ultimate economy and which will permit track to be maintained with the least difficulty.

NEW BOOKS AND PUBLICATIONS.

[621. 138.5 (.43), 625. 19 (43) & 625. 26 (.43)]

ERHALTUNGSWIRTSCHAFT : **Die wirtschaftliche Erhaltung der Fahrzeuge, Maschinen, Geräte und Weichen in den Ausbesserungs- und Betriebswerken der Deutschen Reichsbahn (The economics of maintenance work : Economical maintenance of locomotives and rolling stock, machines, tools, and points and crossings in the German State Railway Company's main repair shops and current maintenance shops.)** — One vol. (11 × 8 inches) of 512 pages with 220 figures. Berlin, 1933. Published under the guidance of Dr. Ing. P. Kühne, Geheimer Baurat und Reichbahndirektor, by the Verkehrswissenschaftliche Lehrmittelgesellschaft m. b. H. bei der Deutschen Reichsbahn. (Price : 30 Rm.).

This valuable book written by Dr. P. Kühne, with the collaboration of many specialists, forms a complete review of the reorganisation carried out on the Reichsbahn in the services responsible for the repairs to the fixed plant and rolling stock, during the last few years. During this period the shop methods have been very greatly altered by the application of the principles of scientific organisation : specialisation of the shops, standardisation of types, patterns, dimensions and materials, mass production or work on the belt system under the control of the production or planning offices.

The work describes in all their details these new methods, and the remarkable results obtained as regards savings of material and labour, and as regards the time the stock is out of service.

The first chapters are devoted to historical notes on the development of the organisation of the repair services and on the policy of centralisation and specialisation of the shops followed; the bases of scientific organisation are also given with special insistence on the need for close collaboration between the designing staff, the services using the equipment, and those who have to repair it; the builder should have constantly in mind the operating conditions and the need to be able to carry out repairs cheaply; the repair and maintenance services ought on their side to report the results of enquiries into failures and wear, suggest the necessary improvements, point out defects in design, and call the attention of the operating departments to any causes of misuse. Constant and efficient collaboration between these three services is essential if a just balance is to be obtained between the manufacturing, operating, and repair costs, which should result in the most economical conditions.

The book then considers the general principles involved in establishing repair shops : their lay-out, dimensions, and the grouping of the machine tools are mainly dependent upon the application of the belt system. These principles are illustrated by many diagrams and plans of new shops or of plant rearranged to adapt it to the new organisation. The whole of this information forms a particularly valuable documentation when investigating schemes for new constructions or for rearranging locomotive, carriage, or wagon repair shops.

The work then considers modern working methods, specialisation of gangs, the belt system of working, mass production, the method of working by interchanching standardised parts, drawing up of works programmes, planning the work, periods stock is out of service, transport between different

parts of the works, and inspecting the quality of the work done.

The description given of the organisation of locomotive repair shops at Mülheim-Speldorf enables the reader to appreciate the function of the organising office in all its details : the whole of the documents required in doing the work are reproduced, explained and analysed : statements of the repairs to be done, duty tables, progress tables, labour tickets, material delivery notes, time keeping documents, etc...

Having clearly explained in this way the general organisation of the repair shops, the book goes on to describe particular features of the different sections and subsidiary shops.

The chapter devoted to the locomotive repair shops gives diagrams of the organisation of the belt system in the erecting, boiler, tube, rod, axle box, piston, wheels, brake, etc..., sections; the methods of squaring up the frame, the measuring devices, the working drawings are described; a series of photographs show the locomotive and the boiler at different stages of the repairs. The paragraphs referring to the carriage and wagon repair shops are dealt with in the same way; the shops dealing with repairs to bogies, springs, wheels, brake gear, and to carriage electric lighting and heating, etc., are also considered.

An important chapter is devoted to the electric locomotive and motor coach repair shops; a number of shop drawings show the different stages of the belts and subsidiary belts; photographs of the equipment employed illustrate the text describing the organisation in all its details. Other chapters conceived on the same lines deal with the shops in which repairs to the permanent way equipment, signalling, and telegraph plant, road motors, etc... are carried out.

The work then passes on to a description of the modern equipment and tools of the shops : cranes, turntables, machine tools, measuring devices, locomotive weigh bridges, degreasing plant for dealing with details, the question of the supply of power, steam, hot water, compressed air, and gas for autogenous welding.

The standardisation of the types of vehicles, and of the materials, patterns and dimensions of their details, the use of limit gauges, materials specifications, organisation of the inspection work, material testing plant, stores and their equipment, the work of the purchasing department, the reorganisation of the workshop accountancy : all these questions are examined under all their aspects in the light of the modern principles of the scientific organisation of work.

A fully developed chapter deals with the running repairs of the locomotives and rolling stock : diagrammatic drawings of the repair shops, the scientific organisation of the work, the staff needed, etc...

The work ends with an analysis of the basic instructions of the Reichsbahn on the repairs and maintenance of the stock; and finally the author examines the questions of the establishments of staff for these services.

This short analysis shows the large amount of valuable information this work brings to the notice of railway engineers concerned with the repairs of rolling stock. A work of this kind, full of the most fruitful ideas on scientific organisation, should appeal not only to transport technicians, but also to all those who in no matter what industry have to secure the proper maintenance under really economical conditions of any important equipment.

A. C.

[656. 2 (02]

TAJANI (Ing. Filippo), Professor at the Royal Technical School of Milan. — **Trattato Moderno di Materiale Mobile ed Esercizio delle Ferrovie.** — Volume II : **Esercizio technico. — Impianto delle Stazioni. (Treatise on modern railway rolling stock and operation.** — Volume II : **Technical operation and station equipment.** 2nd edition, revised and enlarged.) One vol. (10 × 7 inches) of 430 pages with 10 plates and numerous illustrations. 1933, Milano, Libreria Editrice Politecna di Cesare Tamburini fu Camillo, via G. Pascali, 55; Piazza Cavour, 2. (Price : 50 lire.)

This volume contains the third and fourth parts of the treatise, the third dealing with technical operation, and the fourth with the stations.

The technical operation includes two sections on the movement of trains and stock, signals and safety appliances.

Under the first, the author considers the loads of the locomotives in terms of the speed and gradients, and the brake regulations, the preparation of the timetables by using diagrams of the running of the trains, and the occupation of the station sidings, the system of train headways and their effect on the capacity of the lines, the rules governing the utilisation of the locomotives and rolling stock and the general organisation of the goods services.

The second section gives first of all a description of the principal types of signals in use in different countries and indicates the application thereof to the lines and in the stations. The description of the mechanical interlocking systems is followed by that of the power systems, such as hydrodynamic, pneumatic, electropneumatic, electric. The general theory of interlocking is supported by two practical examples : a junction and a passing station. The organisation of the block system is then set out for a double track line with a description of the Siemens appliances and also on single track lines; the automatic block is dealt with and with the development the subject calls for. Particulars are given of recent applications of daylight (colour light) signals and of level crossing signals.

The consideration of the stations, the subject of the second part, is based on the classification of stations into small, medium, junctions, large stations, maritime stations, and service yards. To be truthful, the differences lie chiefly in the arrangement of the lines or groups of sidings. The author goes on to describe the installation required for operating purposes and those for traffic needs. We prefer a classification which takes into account not only the importance of the stations but also their specialisation or non-specialisation.

On the subject of shunting sidings, the author devotes special attention to the layout of the heads of the groups of sidings, and to the braking question.

The last chapter gives useful data on the water service, the coal yards, the locomotive depots and the track in the yards.

E. M.